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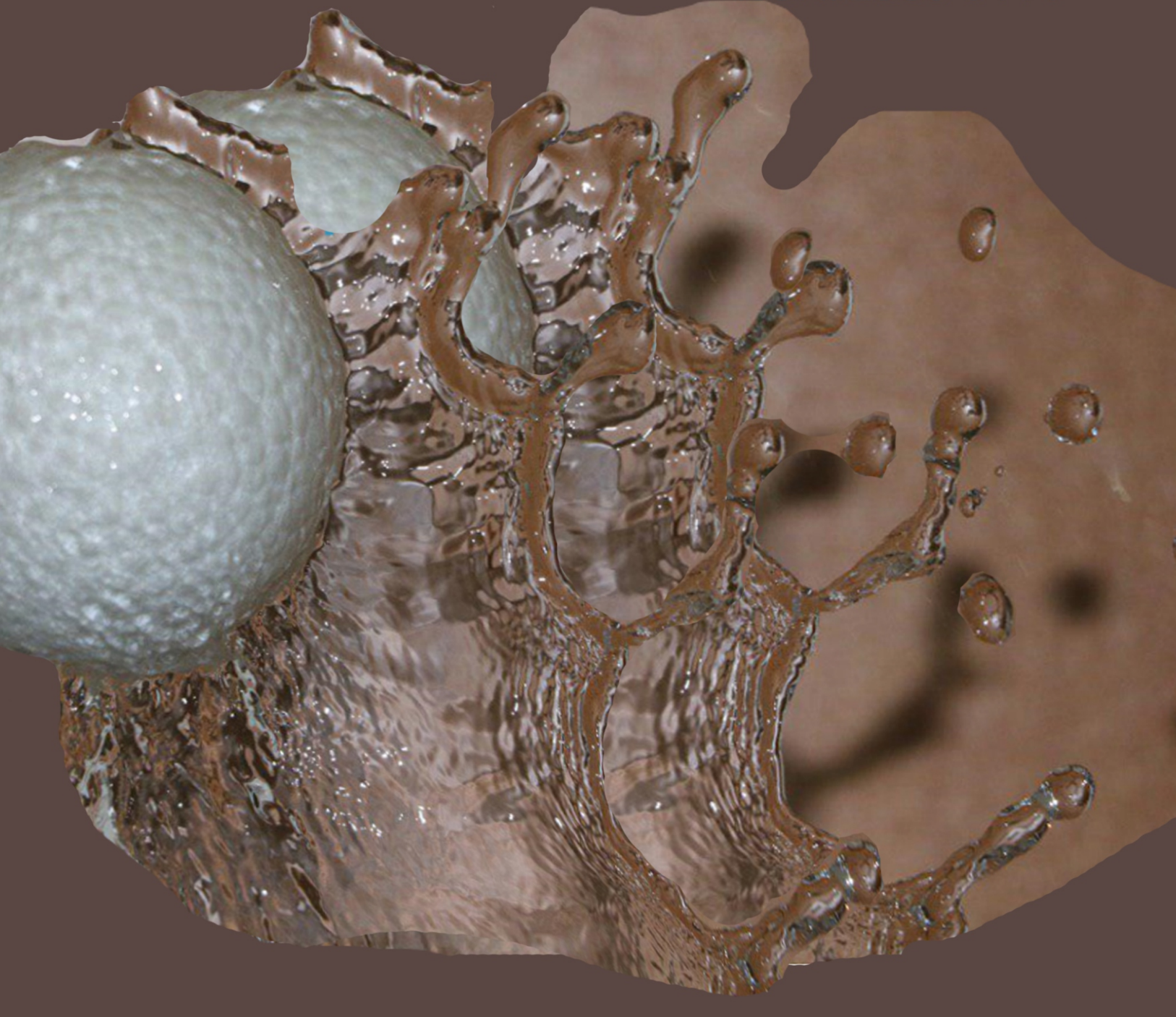

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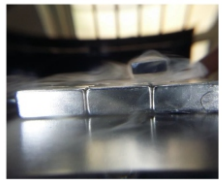

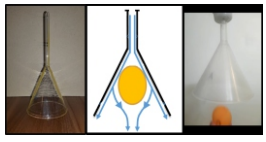

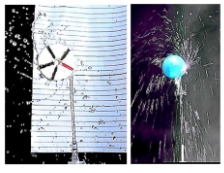

Young Scientist Research

Address:
Unit 14, No.32, Malek Ave., Shariati St.
Post Code: 1565843537
Tel:+9821-77507013, 77522395

Current Issue
Vol 3 NO 2 DEC 2019

WELCOME TO THE INTERNATIONAL JOURNAL of YOUNG SCIENTIST RESEARCH

Young Scientist Research is a research journal based on scientific projects and we are pleased to present our students' work in scientific activities. This open-access journal includes young students' research in any field of science which publishes full-length and abstract research on any aspects of applied sciences in relation to work presented in both national and international conferences, competitions and tournaments of all types.

Programs that have educational opportunities for high school students to present their distinguished projects from regional, national and international events such as International Conference of Young Scientists (ICYS), International / Persian Young Physicists' Tournament (IYPT/ PYPT), International / Iran Physics' Tournament (IPT/ IRPT).

New manuscripts sent to the Journal will be handled by the Editorial Office who checks compliance with the guidelines to authors. Then a rapid screening process at which stage a decision to reject or to go to full review is made.

By submission of a manuscript to the Journal, all authors warrant that they have the authority to publish the material and that the paper, or one substantially the same, has neither been published previously, nor is being considered for publication elsewhere.

This journal belongs to Ariaian Young Innovative Minds Institute, AYIMI, and one to two issues is published in a year. All details are on the YOUNG SCIENTIST RESEARCH Journal website (http://journal. ayimi.org)

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Dr. Dina Izadi
Researcher & President
AYIMI & ADIB
International Research & Artistic Institutes
http://www.ayimi.org, http://adib.ayimi.org
Email: info@ayimi.org
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Report : Regional Conference on Women In Physics, Nepal (NRCWIP, 2019)

The first regional conference on Women in Physics (RCWIP) was held in Pakistan on, April 25-27, 2016 which Jointly Organized by the National Centre for Physics (NCP) Islamabad, Pakistan , the Department of Physics & Electronics, University of Peshawar (UoP) Pakistan , the Centre for Physics Education (CPE) Karachi, Pakistan and The Abdus Salam International Centre for Theoretical Physics (ICTP) Trieste, Italy . The event was held at NCP, Quaid-e- Azam University (QAU) Campus, Shahdara Valley Road, Islamabad, Pakistan. The Scientific Secretary was Anisa Qamar (UoP).

The second Regional Conference on Women in Physics (RCWIPN 2019) took place from 27 to 29 March 2019 at Kathmandu University, Dhulikhel, Nepal. The Nepalese Society for Women in Physics (NSWIP) in association with Tri-Chandra Multiple Campus, Tribhuvan University were hosting the conference. The main objective of the conference, adhering to IUPAP principle 'Universal access to and Participation in science', was 'Fostering Professional Development and Nurturing Future Women Leaders'.

Starting program by Prof. Dr.Nilam Shrestha (Chairperson NSWIP)

The Country Papers reported the status of Women in Physics in the form of posters, oral and Skype presentation and coordinated by the Country Team.

Scientific talks on physics and papers were associated to any related physics and invited speakers were from Pakistan, Iran, Bangladesh, India, Canada, Japan, Nepal.

The first day, March 27,2019:

	Talks on Physics
Anisa Qamar	Magnetic Reconnection
Farida Tahir	Neutrino Mass; Mystery, no more!
	Talks on Women Education in Physics
Shamima Choudhury	Gender Equality in Science and Engineering
Dina Izadi	Linking The Art with Science by ORIGA – SCIE as STEAM Education
Gauri Shrestha	Status of Women Physicists in Nepal

Day 2 program on March 28, was the sessions with talks on physics and women education in physics by invited speakers and participants. Day 3 was talks on physics by participants and guest speakers. Prof. Michael Steinitz from Canada presented two topics, Mechanics of scientific publishing, peer review and ethics in publishing and the second one about the international year of basic sciences for development. Two talks on women education in physics were the last presentations. Prof. Adriana Predoi Cross from Canada was one of them who had a contributed talk by Skype which was on mentoring and promoting women in physics.

Posters were evaluated in Day 3 in parallel session with oral presentation. Before the ending program and award session, panel discussion with the participants was managed by Dr. Nilam , Anisa Qamar, Shamima Choudhury, Aziz Fatima Hasnain and Setsuko Tajima .

SUPERCONDUCTING AND MEISSNER EFFECT

Farbod Hassanzadeh, Shahriar Toos High School, Mashhad, Iran, farbodhz7@gmail.com

ARTICLE INFO

Winner of Special Diploma in Chemistry tournament, IChTo 2018, Moscow State University

Accepted in country selection by Ariaian Young Innovative Minds Institute , AYIMI

http://www.ayimi.org ,info@ayimi.org

ABSTRACT

The main problem is about Arodnap and flying islands. On the planet Arodnap, the average atmospheric temperature is about 60 K and it doesn't fluctuate much during day and night. We may find there some levitating islands, like the ones from the Avatar movie. Of course, the planet Arodnap is fictional. However, we should try to come up with a plausible mechanism of the formation of such islands and to investigate which processes could lead to the formation of specific minerals, that are in charge of these effects? We are going to suggest, based on this mechanism, the features of Arodnap: its geological history, a composition of the atmosphere and crust and so on.

1 Introduction

Superconductivity and the phenomenon of floating object in a magnetic field, is a phenomenon that is emerging for some materials in certain circumstances. The main issue is how to float this material.

Superconductivity is a phenomenon that happens at exactly zero electrical resistance and expulsion of magnetic flux fields which occurs in certain materials, called superconductors . Superconductors are made due to cooling below a characteristic critical temperature. It was discovered by Dutch physicist Heike Kamerlingh Onnes on April 8, 1911, in Leiden. Like ferromagnetism and atomic spectral lines, superconductivity is a quantum mechanical phenomenon. It is characterized by the Meissner effect, the complete ejection of magnetic field lines from the interior of the superconductor during its transitions into the superconducting state. The Meissner effect indicates that superconductivity cannot be understood simply as the idealization of perfect conductivity in classical physic

The electrical resistance of a metallic conductor decreases gradually as temperature is lowered. In ordinary conductors, such as copper or silver, this decrease is limited by impurities and other defects. Even near absolute zero, a real sample of a normal conductor shows some resistance. In a superconductor, the resistance drops abruptly to zero when the material is cooled below its critical temperature. An electric current through a loop of superconducting wire can persist indefinitely with no power source.

In 1986, it was discovered that some cuprate-perovskite ceramic materials have a critical temperature above 90 K (−183 °C). Such a high transition temperature is theoretically impossible for a conventional superconductor, leading the materials to be termed high-temperature superconductors. The cheaply-available coolant liquid nitrogen boils at 77 K, and thus superconduction at higher temperatures than this facilitates many experiments and applications that are less practical at lower temperatures .

2 Theory and Modeling

2-1 Meissner Effect

When a superconductor is placed in a weak external magnetic field and cooled below its transition temperature, the magnetic field is ejected. The Meissner effect does not cause the field to be completely ejected but instead the field penetrates the superconductor but only to a very small distance, characterized by a parameter λ , called the London penetration depth, decaying exponentially to zero within the bulk of the material. The Meissner effect is a defining characteristic of superconductivity. For most superconductors, the London penetration depth is in the order of 100 nm.

The Meissner effect is sometimes confused with the kind of diamagnetism one would expect in a perfect electrical conductor: according to Lenz's law, when a changing magnetic field is applied to a conductor, it will induce an electric current in the conductor that creates an opposing magnetic field. In a perfect conductor, an arbitrarily large current can be induced, and the resulting magnetic field exactly cancels the applied field

The Meissner effect is the spontaneous expulsion which occurs during transition to superconductivity. Suppose we have a material in its normal state, containing a constant internal magnetic field. When the material is cooled below the critical temperature, we would observe the abrupt expulsion of the internal magnetic field, which we would not expect based on Lenz's law (Eq.1)[1].

$$\nabla^2 \mathbf{H} = \lambda^{-2} \mathbf{H} \tag{1}$$

Where H is the magnetic field and λ is the London penetration dept. This equation, which is known as the London equation, predicts that the magnetic field in a superconductor decays exponentially from whatever value it possesses at the surface.

2-2 Different Types of Superconductors

We have two type of superconductors, superconductors type I and type II. In superconductor type: I if magnetic field increases from the base (H_C) , superconductor suddenly disappears. (H-C) is a limit of the magnetic field. Most of the superconductors type 1 are simple elements except (Tc. V. carbon Nano layers) (Fig 1). Depending on

the geometry of the sample, one may obtain an intermediate state consisting of a baroque pattern of regions of normal material carrying a magnetic field mixed with regions of superconducting material containing no field [2].

In Type II superconductors, raising the applied field past a critical value Hc1 leads to a mixed state (also known as the vortex state) in which an increasing amount of magnetic flux penetrates the material, but there remains no resistance to the flow of electric current as long as the current is not too large. At second critical field strength Hc2, superconductivity is destroyed. The mixed state is actually caused by vortices in the electronic superfluid, sometimes called fluxion (Fig. 2).

Most pure elemental superconductors, except niobium and carbon nano-tubes, are Type I, while almost all impure and compound superconductors are Type II.

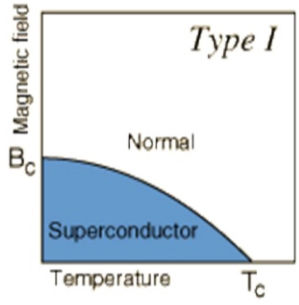

Fig.1: Superconductivity, Type I

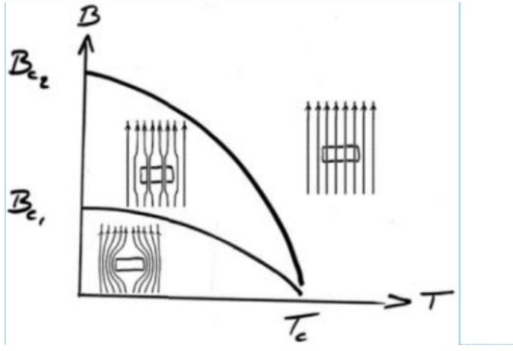

Fig.2: Superconductivity, Type II

Elements that they are superconductor type: I , with their Tc in kelvin are as written in table (1) and compounds with their superconductivity in table (2).

Table 1: superconductor Type I, elements

element	Tc	element	Tc	element	Tc	element	Tc	element	Tc
Al	1.175	Hgβ	3.949	Nb	9.25	Ru	0.49	V	5.40
Be	0.026	In	3.408	Os	0.66	Sn	3.722	w	0.0154
Cd	0.517	Ir	0.1125	Pa	1.4	Ta	4.47	Zn	0.850
Ga	1.083	Laα	4.88	Pb	7.196	Tc	7.8	Zr	0.61
Hf	0.128	Laβ	6.0	Re	1.697	Th	1.38	Tl	2.38
Hgα	4.154	Lu	0.1	Mo	0.915	Ti	0.40	-	

Table 2: Compounds are superconductor type: II and Tc in kelvin

Compounds	T_c
Nb_3Sn(Niobium- tin)	18
Nb_3Ge (Niobium-germanium)	23.2
V_3Si	17.1
$La_{1.8}\ Sr_{0.2}\ CuO_4$	35
$YBa_2Cu_3O_7$	95
$Tl_2Ba_2Ca_2Cu_2O_{10}$	125
$Y_{0.6}\ Ba_{0.4}\ CuO_4$	90
$Bi_{1-x}KxBiO_3$-Y	27

3 Experiment

On the planet Arodnap, the average atmospheric temperature is about 60 K and it doesn't fluctuate much during day and night (Fig. 3). To design some levitating islands, and explain the science behind it to come up with a plausible mechanism of the formation of such islands, we have used the properties of superconductivity.

To find the mechanism in order to solve this problem; some properties such as the type of superconductor disk, mass, ingredient, maximum resistance to magnetic field and the intensity of the magnetic field in terms of Tesla or Gauss should be considered. The suspension of the disk occurs by putting superconductor disk on the magnetic field .By using a texture disk, we can reverse the magnetic field without the disk falling. This happens because the magnetic field is locked into the superconductor disk.

Fig. 3: Floating Island [3]

We used superconductor type II and it should be texture to lock into magnetic field and also we used neodymium magnetic field because it is strong.

For suspending the superconductor disk ($YBa_2Cu_3O_7$) at first we have to have liquid nitrogen to cool down the superconductor disk then we need a strong magnetic field. At first we cooled down the superconductor disk then put it in the magnetic field, instantly . Then the superconductor disk started to be suspended with a liquid nitrogen vapor around it (Fig.4).

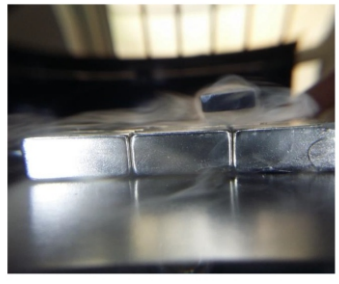

Fig.4: Experiment procedure and suspension of superconductor disk

4 Conclusions

According to this experience we understood to find and build some levitating islands, like the ones from the Avatar movie , in a planet which is fictional. The mechanism of the formation of such islands which could lead to the formation of specific minerals, that are in charge of these effects, is similar to floating of a superconductors in a magnetic field. We tried to suspend a superconductor disk with some important parameters such as the mass of superconductor disk, type of the material and power of the magnetic field are considered.

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FUNNEL AND THE BALL

Mahan Mottaghi Raad, Sama School, Mashhad, Iran, mahanmotaghiraad@gmail.com

ARTICLE INFO

Winner of Bronze Medal in ICYS 2019, Malaysia

Accepted in country selection by Ariaian Young Innovative Minds Institute , AYIMI

http://www.ayimi.org ,info@ayimi.org

ABSTRACT

Funnel and ball is an educational experiment in which by placing a ball inside a funnel while a stream of air is flowing through it, it can be observed that in correct conditions a pick up force will be implied onto the ball, which makes the ball to levitate inside the funnel. In this research we are going to investigate the parameters which affect this experiment and what relation between this parameters cause a better result in an ideal system. The pick-up force is caused due to the difference of pressure which is implied onto the ball and to have a successful pick up there is an important relation between physical properties of the ball (e.g. mass, volume) and air flow (e.g. velocity, stability).

1 Introduction

Funnel and ball is an educational experiment in which by placing a ball inside a funnel while a stream of air is flowing through it, a suction force will be created which happens due to the difference of pressure created inside the funnel, this suction force might be strong enough to keep the ball inside of it even though the direction of air flow is against it. In this article you will read an explanation behind why this phenomenon happens, what are the parameters which affect this experiment and what relation between this parameters can cause a better result in an ideal system (Fig. 1) .

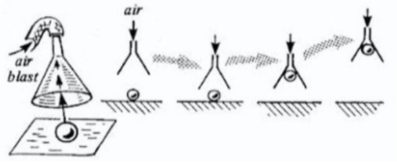


Fig. 1: Funnel and the ball

2 Experimental Setup

For performing this experiment, we need a funnel, a light ball (e.g. Ping-pong ball) and a stable source of stream of air.

Considering the properties of these equipment, it is best to use a ball with a high volume and low mass along with a funnel with a low angle in order to be able to work easily with different varieties of air velocities.

3 Theoretical Analysis

In fluid mechanics, Bernoulli's principle states that fluids with higher velocity will have less pressure; this principle gives us the relation between pressure and velocity of the fluid in every cross section of the funnel. According to another principle, which is volumetric flow rate, fluids passing through a narrow pipe will have more velocity.

According to the continuity in the funnel when the ball is picked up with the air pressure, the air's velocity inside the funnel , which the ball is in middle of it, increases because the cross section is small there and the air's velocity decreases under the ball in funnel because the cross section is big there so according to this might be explained by Bernoulli principle or Coandă effect. According to the Bernoulli's law when the air's velocity decreases , under the ball in the funnel, the pressure increase and help the ball to pick up (Fig.2).The Coandă effect is the tendency of a fluid jet to stay attached to a solid surface (Fig.3) [1 & 2].

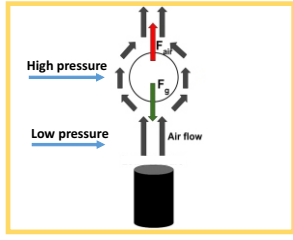


Fig. 2: Bernoulli's principle

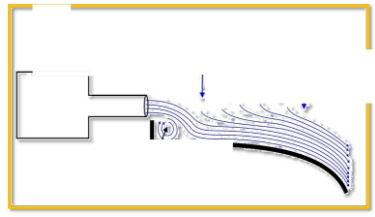


Fig. 3: Coandă effect

We can analyze the movement of the ping-pong ball in the funnel by plotting the X and Y components of the position of the ball versus time. Some of the important parameters which should be considered are the weight and size of the ball, airflow rate, and the shape of the funnel.

In the following diagram (Fig.4), the main forces, which are applied to the ball are shown.

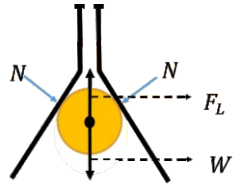


Fig. 4: The main forces applied to the ball in the funnel

Theoretically the data which will be gathered using this information will show that the sum of pressure above the ball is lower than from its below, this difference of pressure in some conditions might create enough suction force for it to be able to keep the ball inside of it.

3-1 Upwards force(F_{up})

This force is formed because of the difference in pressure below and above the ball, which makes the ball to get lifted upwards. Upward force is measured by the equation (1).

$$F_{up} = 4c\pi^2R^2 - \frac{\rho V_0^2 A_0^2 R^2}{\pi}\int \frac{\cos\varphi\, d\varphi}{(y-R\sin\varphi)^2\tan^2\theta - R^2\cos^2\varphi)} \quad (1)$$

$F_L > W \rightarrow$ ***ball sticks to te funnel.***

$F_L = W \rightarrow$ ***ball levitates in the funnel.***

$F_L < W \rightarrow$ ***ball falls down.***

This force has the same properties of lift force but the direction of pick-up force is not perpendicular to the direction of airflow, so it could not be considered as a lift force (Eq. 2-5) (Fig.5) .

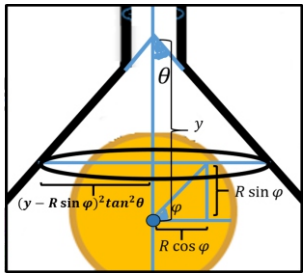


Fig. 5: The components of the main forces applied to the ball in the funnel

$$A = \pi((y - R\sin\varphi)^2\tan^2\theta - R^2\cos^2\varphi) \quad (2)$$

$$V = \frac{V_0 A_0}{\pi((y-R\sin\varphi)^2\tan^2\theta - R^2\cos^2\varphi)} \quad (3)$$

$$P = c - \frac{1}{2}\rho(V_0^2A_0^2\frac{1}{\pi^2((y-R\sin\varphi)^2\tan^2\theta - R^2\cos^2\varphi)^2}) \quad (4)$$

$$F_L = \int \mathrm{PdA} \longrightarrow F_L = \int PdA \longrightarrow F_L = 4c\pi^2R^2 - \frac{\rho V_0^2 A_0^2 R^2}{\pi}\int \frac{\cos\varphi\, d\varphi}{(y-R\sin\varphi)^2\tan^2\theta - R^2\cos^2\varphi)} \quad (5)$$

In Coandă effect Stream lines are connected to the solid objects are walls of the funnel and surface of the ball (Fig.6).

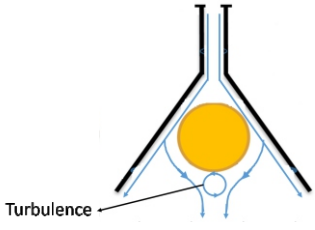


Fig. 6: Turbulence causes in Coandă effect

3-2 Drag force(F_D)

This force is formed by the friction and the momentum created between the ball and the gas particles at the moment of impact which makes the ball to get pushed downward. This force is measured by equation (6).

$$F_D = \frac{1}{2}\rho A V^2 C_D \quad (6)$$

3-3 Weight force (F_W)

This force is created as a result of the gravitational force exerted to the ball's mass. Weight force is measured by the equation (7).

$$F_W = \mathrm{mg} \quad (7)$$

Using these three main equations, we can predict if in any case the ball's levitation will be successful; in order the ball be able to levitate inside the funnel, amount of the lift force must be equal or above the amount of drag and weight force (Eq. 8).

$$F_{up} \geq F_D + F_W \rightarrow ball\ levitates\ in\ the\ funnel. \quad (8)$$

4 Experiments and Results

The parameters which are effective in this experiment are explained in more details.

Mass of the ball: by increasing the mass of the ball with a constant volume, amount of weight force will get increased which in correct amounts it will make the addition of drag and weight force to get higher than the amount of upwards force which in this case the ball would not levitate.

According to the results in our experiment by increasing the mass of the ball (Fig.7), minimum velocity of the ball is increased and levitation force will be decreased (Table 1) and (Fig. 8).

Table 1: Velocity of different balls in the funnel

Mass: 2.30 g	⟶ minimum velocity: 1.74 m/s
Mass: 6.39 g	⟶ minimum velocity: 2.05 m/s
Mass: 11.08 g	⟶ minimum velocity: 2.31 m/s

Fig. 7: Balls with different masses

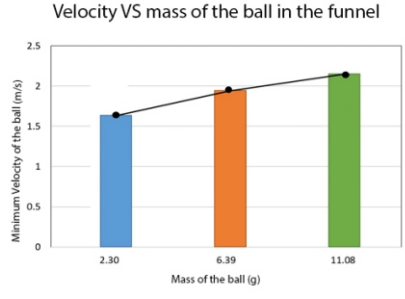


Fig. 8: Minimum velocity of the balls with different masses in the funnel

Volume of the ball: by increasing the volume of the ball with a constant mass (Fig. 9), the distance between top of the ball and its bottom will get increased which according to volumetric flow rate and Bernoulli's principle the

difference of pressure above and below the ball will get increased which makes the ball to levitate with more stability (Fig. 10) (Eq. 9 and 10).

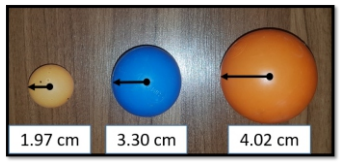


Fig. 9: Balls with different radius (volume)

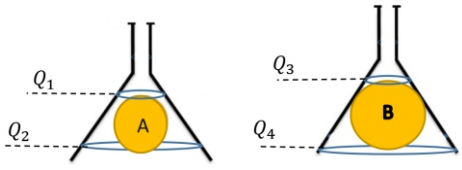


Fig. 10: Balls with different volumes inside the funnel

$$Q = A.V \xrightarrow{A_1=A_3\,,\ V_1=V_3\,,\ A_2<A_4\,,\ V_2<V_4} Q_1 + Q_2 < Q_3 + Q_4 \quad (9)$$

$$\xrightarrow{\frac{v^2}{2}+gh+\frac{p}{\rho}=const.} P_1 = P_3\,,\ P_2 < P_4 \longrightarrow \Delta P_A < \Delta P_B \quad (10)$$

According to the results in our experiment, by increasing the volume of the ball , its velocity decreases so the levitation force will be increased (Table 2) (Fig. 11).

Table 2: Velocity of different volumes of the balls

Radius: 1.97 cm ⟶ minimum velocity: 1.39 m/s
Radius: 3.30 cm ⟶ minimum velocity: 1.08 m/s
Radius: 4.02 cm ⟶ minimum velocity: 0.94 m/s

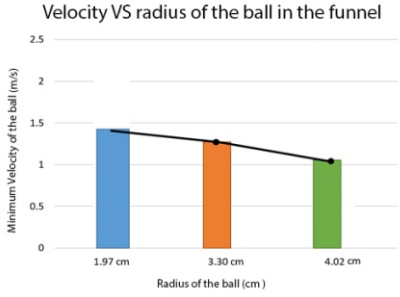


Fig. 11: Minimum velocity of the balls with different volumes

Angle of the funnel: as angle of the funnel changes, the difference of cross section above and below the ball will change (Fig.12). According to volumetric flow rate by increasing the angle, difference of velocity in the funnel will increase which according to Bernoulli's principle difference of pressure inside the funnel will increase which makes the ball to levitate inside the funnel with more stability (Fig. 13) (Eq.11).

$$A_2 - A_1 > A_4 - A_3 \longrightarrow V_2 - V_1 > V_4 - V_3 \quad (11)$$

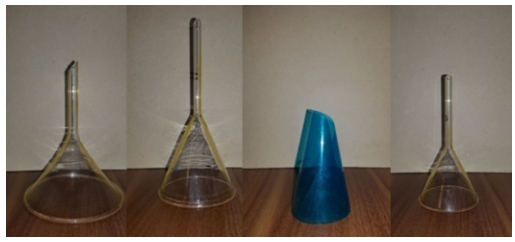


Fig. 12: Different shapes of the funnel with different angles, curves and heights

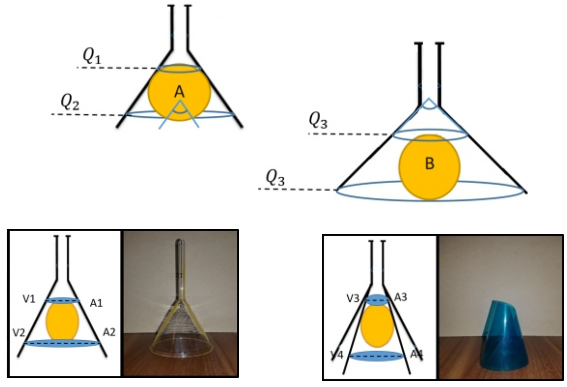


Fig. 13: Funnels with two different angles

Different shapes of funnels are compared with each other; a flat funnel with a curved one and also two different heights (Fig. 14 , a and b ;c and d).

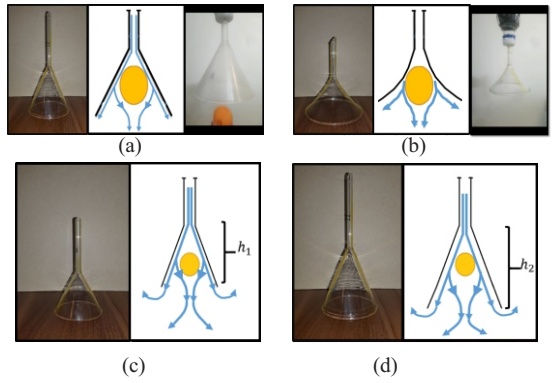


Fig. 14: Different funnels, flat (a) and curve sides (b); short (c) and tall height (d)

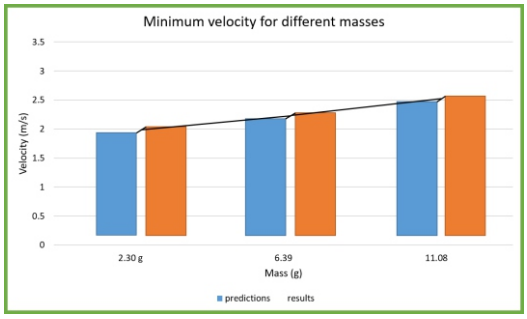
5 Results and Conclusions

We have compared our prediction by theory and the results from the experiments both in different masses and different volumes (Fig. 15 a and b).

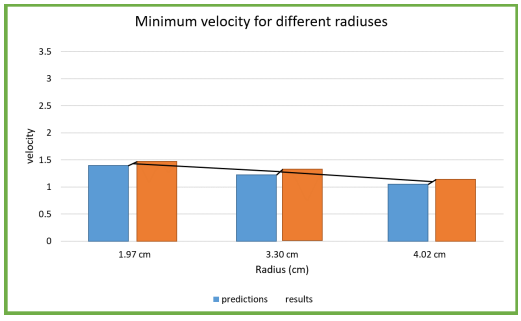
The basic reason why this phenomenon happens is the difference of pressure created inside the funnel.

Ideally, the main forces, which are applied to the ball, are upwards force, drag force and weight force.

According to the experiments we can understand that to improve results of this experiment is best to use a ball with higher volume and lower mass.



(a)



(b)

Fig. 15: Comparison between theory and experimental results in balls with different masses (a) and different radiuses(b)

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DANCING BALL

Mahsa Geramimanesh, Farzanegan 2 High School, Tehran, Iran, geramimanesh@gmail.com

ARTICLE INFO

Winner of Bronze Medal in ICYS 2019, Malaysia and Bronze Medal in IYPT 2019, Warsaw University of Technology (Team Iran)

Accepted in country selection by Ariaian Young Innovative Minds Institute , AYIMI

http://www.ayimi.org ,info@ayimi.org

ABSTRACT

A Styrofoam disc or ball can be levitated by a water jet. In this phenomenon lots of principles take part and totally they cause the disk to remain stable for some time. In this paper, the most effective parameters are investigated such as the mass and volume of the ball, the flow rate of the water and the shape of the object (disc/ball). Depending on optimum parameters the object can withstand air turbulence, switching the objects, sudden water pressure drop and tapping the object, as external disturbances.

1 Introduction

When a light object, such as a Styrofoam disk is placed on a water jet, under certain conditions, the object will start to spin while being suspended. This phenomenon and its stability to external perturbations are investigated. Through the observations and experiments, theory of momentum and instabilities, and several parameters such as angel ,flow rate and hydrophobicity versus rotational speed are studied (Fig. 1) [1 &2].

Fig. 1: Rotation of a Styrofoam disk on a water jet

2 Theory and Experiments

By placing a Styrofoam ball in different masses and volumes on the edge of water jet various behaviors of ball are observed such as creating a sheet of water or drop ligaments. The experimental setup contains a tube which provides water jet and a ruler that measures how much the water jet can rise up and the alternation of ball's height in this experiment. The effective parameters namely mass, object's geometry (shape, diameter), properties of the water jet, object's roughness (friction) and external disturbances (switching the objects, air turbulence, sudden water pressure drop, tapping the object) were investigated (Fig. 2). A small part of the water jet which has an efficient area and a displacement is considered so a small part of this volume of the water jet is equal to (Eq. 1 and 2):

$$dV = Avdt \tag{1}$$

$$dp_{in=v\times}\rho dV \tag{2}$$

So (Eq. 3):

$$\frac{dp_{in}}{dt} = \rho Av^2 \tag{3}$$

Fig. 2: Experimental setup

We assume the momentum of the water jet and drops throwing out of the ball are propulsion with each other (Eq. 4) (Fig. 3).

$$\frac{dp_{out}}{dt} = a' \frac{dp_{in}}{dt} \tag{4}$$

So the force applied to the system is equal to (Eq. 5):

$$F = (1-\alpha')\frac{dp_{in}}{dt} = \alpha\frac{dp_{in}}{dt} = \alpha\rho Av^2 \tag{5}$$

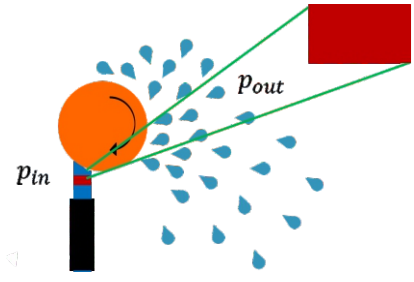


Fig. 3: Momentum of the water jet and drops throwing out

In steady state the applied force to the ball by the water jet is equal to the weight of the ball so the coefficient which is related to the properties of the ball and is calculated (Eq. 6-10).

$$AV = D \quad \rho Av^2 = \rho Dv = \rho D\sqrt{v^2_{-2gy}} \tag{6}$$

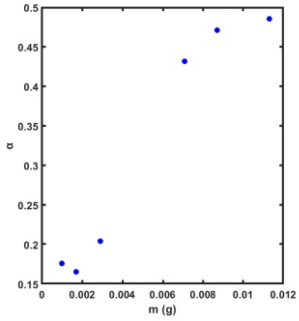
$$F = \alpha\rho D\sqrt{\frac{D^2}{A^2} - 2gy} = mg \quad (7)$$

$$D^2y = \frac{D^4}{2gA^2} - \frac{m^2g}{2\alpha^2\rho^2} \quad (8)$$

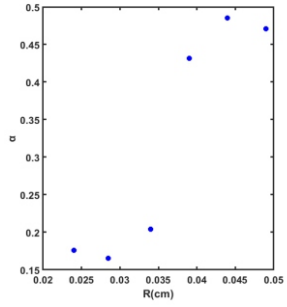
$$D^2y = X\frac{1}{2gA^2} - \frac{m^2g}{2\alpha^2\rho^2} \quad (9)$$

$$\alpha = \sqrt{-\frac{m^2g}{2A\rho^2}} \quad (10)$$

Now the relation between α and mass of the ball and also in different radius are plotted . (Fig. 4a and b).



(a)



(b)

Fig. 4: a) α in different mass of the ball, b) in different radius of the ball

What is the reason of observing these kind of the reactions of the ball? Due to Kelvin Helmholtz instability when two different fluids want to move on each other, it causes some waves and due to Rayleigh-Taylor instability these waves because of two different accelerations: gravity and centrifugal force, grow and become to ligaments or water drops (Fig. 5). These different situations depend on different parameters such as mass or flow rate of the water jet or other parameters which will causes different reactions of the object. If the centrifugal force is larger than surface tension, these waves will grow and if vice versa happens, waves could just be damped by the surface tension.

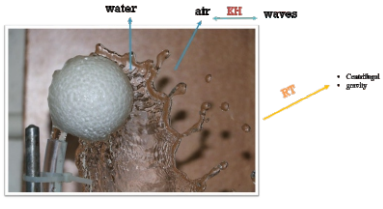
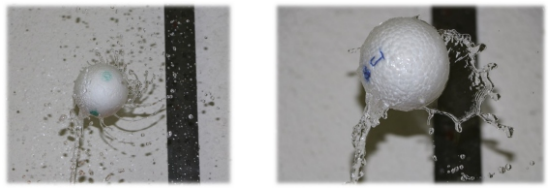


Fig. 5: growing of ligaments

So as we already mentioned based on the different properties of the ball different reactions could be observed (Fig. 6).



(a) (b)

Fig. 6: a) Ligaments in Drops, b) Sheet of water

Now we change the hydrophobicity of the ball by changing the contact angle of the surface of a disk and a ball (Fig. 7). So different contact angles have been observed (Fig.8) , so with the less contact angle, the object is less hydrophobic and water likes to stay on the surface of the ball and it causes much more rotational speed and the same result was observed for the ball that the hydrophobic one has more ligaments because the drops don't like to attach on the ball so they have inverse relation with each other (Fig. 9).

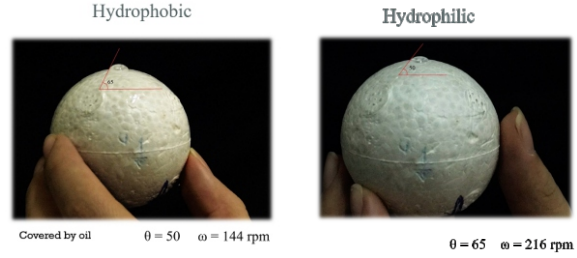
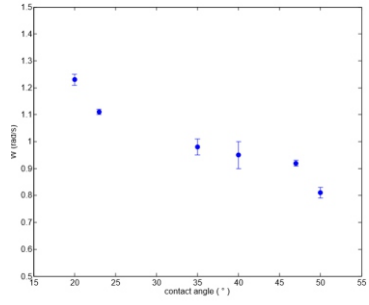


Fig. 7: The behavior of two different hydrophobic and hydrophilic balls



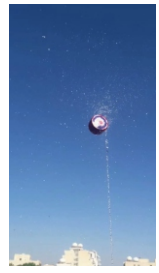
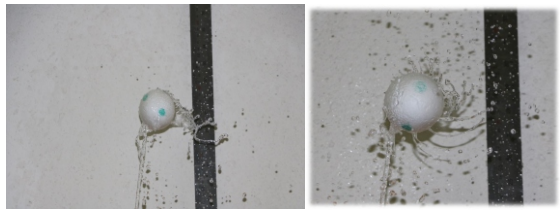


Fig. 8: The rotational speed versus contact angle



(a) (b)

Fig. 9: a) Hydrophilic, b) Hydrophobic patterns

The other parameter that we've changed was the flow rate of the water jet and its effect on the angular velocity of the ball or disk. It is observed that if the flow rate changes, it won't cause any differences to the rotational speed of our ball because the weight of the ball is constant so it needs the

same force of the water jet. If we increase the flow rate, the object will stay in a higher position to be stable . If the weight of the ball is increased, the force of the water jet should increase too, so the ball stays in lower height to get much more force from water jet. In overall the velocity of the collision of the water jet on the ball is important which in different flow rates it will be the same.

Now the external perturbation is considered in our experiments. If we apply a force with a pin, it could easily be observed that the momentum of the right side of the object should be the same with the momentum of the left side , so the momentum of the opposite direction will push the ball to its first place.

Fig. 10: External perturbation

3 Conclusions

To investigate this phenomenon instabilities of the Styrofoam ball in different masses and volumes on the edge of water jet was studied. Creating a sheet of water or drop ligaments depending on hydrophobicity of the ball which causes the change of contact angle of the surface of a disk or a ball was observed too. The flow rate of the water jet and its effect on the angular velocity showed that if the flow rate changes, it won't cause any differences to the rotational speed.

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UNDERTONES AND TUNING FORKS

Rozhan Asadi, Farzanegan 4 High school, Tehran, Iran , hana.r.asadi@gmail.com

ARTICLE INFO

Participated in ICYS 2019, Malaysia

Accepted in country selection by Ariaian Young Innovative Minds Institute , AYIMI

http://www.ayimi.org ,info@ayimi.org

ABSTRACT

Undertone frequencies can only be generated in special and strange situations. This paper investigates if creating an undertone frequency using a tuning fork is possible. The research presented in this paper explores under what circumstances and with what objects undertone can be made using tuning fork.

1 Introduction

Sound is a mechanical disturbance from a state of equilibrium that propagates through an elastic material medium. One can describe tone as a sound that can be recognized by its regularity of vibration. A sound that has only one frequency although its intensity may vary is a "simple tone". A "complex tone" consists of two or more simple tones. The fundamental tone of an object is its lowest natural frequency. Let's consider a mechanical system, a spring which is fixed at one end and has a mass attached to the other end. The natural frequency depends on two system properties: mass and stiffness. The natural frequency is radians per second is measured as ω_n, (Eq. 1).

$$\omega_n = \sqrt{\frac{k}{m}} \quad (1)$$

where, k is stiffness of the spring, and m denotes mass. We write the natural frequency in *Hz* (Eq. 2).

$$f_n = \frac{1}{2\pi}\sqrt{\frac{k}{m}} \quad (2)$$

where , f_n denotes natural frequency in Hertz, K is the stiffness of spring, and m the mass.

The frequency of the first mode is called the "fundamental frequency". Harmonic series is simply a positive integer multiplied by the frequency of a vibrating object. "Overtone" is a term used to refer to any resonate frequency above the fundamental frequency. Any sound-producing source such as a violin string could oscillate as many different larger segments, multiples of the string – one at a time. It is as though the strings were infinitely multipliable with equal parts of itself: two doubles, three triples, four quadruples and so on. These harmonics are called undertones or subharmonics. Acoustically, the undertone series is like a mirror image of the overtone series; its opposite in every way [1]. Undertone frequencies can only be created in special and strange situations.

A tuning fork is an acoustic resonator in the form of a two-pronged fork with the prongs formed from a U-shaped bar of elastic metal. It resonates at a specific constant pitch when set vibrating by striking it against a surface or with an object, and it emits a pure musical tone once the high overtones fade out [2].

In tuning fork's fundamental vibrating mode, the two prongs vibrate 180 degrees out-of-phase with respect to one another.

To analyze the behavior, we simulated vibrating fork's prongs using COMSOL which shows the simulation of vibration and displacement of the tuning fork prongs (Fig. 1)[3].

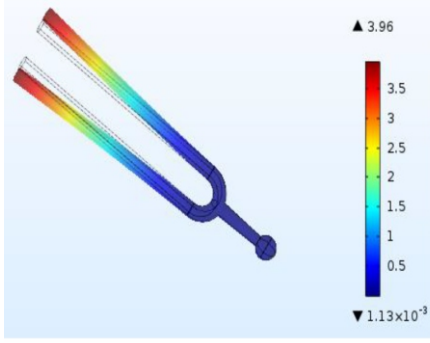


Fig 1: Simulation of vibration and displacement of a turning fork's prongs

A tuning fork has numerous natural frequencies. Many of the frequencies are excited when the tuning fork is struck by an object. But the higher frequencies quickly die [4]. In this research we are going to examine if we can succeed in making undertone frequencies with tuning fork and how this can be achieved and what are the required circumstances.

A tuning fork along can only make overtones. Therefore, it is important to find an object to help us.

2 Experiments

In our experiments, the initial hypothesis was using sheets of materials to create the tone. The sound of a tuning fork with a fundamental frequency of 440 Hz was recorded to determine the accuracy of the tools that we are using in these experiments.

The sound was analyzed in MATLAB. The fundamental frequency in our tuning fork was 440 Hz (Fig. 2).

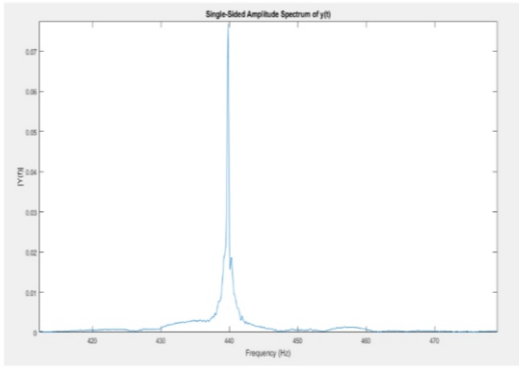


Fig. 2: Single sided amplitude spectrum, sound was analyzed in MATLAB and the fundamental frequency was 440 Hz

Next, three different materials of sheets; paper sheet, aluminum sheet and plastic sheet in deferent sizes were tested. We clamped the sheets to a stand and let them be connected weakly to the head of tuning fork's prong.

In experimenting with aluminum sheets and plastic sheets, we did not reach to spectacular results. However, while experimenting with paper sheets, in some parts some undertones were successfully made.

As it can be seen in Figure (3), the frequency 220 Hz is the first undertone of tuning fork's frequency which was made.

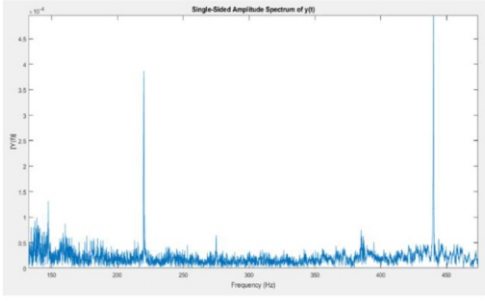


Fig. 3: Frequency plot for the experiment with the paper sheet

As it was mentioned before, the paper is connected weakly in only some parts. In this way, we were able to produce the undertone sound using the paper. Figure (4) illustrates the experiment setup.

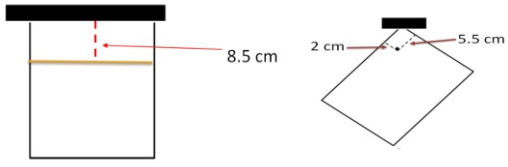


Fig. 4: Experiment setup indicating where undertone was made (top) A5 paper, and (bottom) A4 paper.

The points where the undertone was made in an A5 paper were on a line 8.5 cm away from its width where it was clipped. When A4 paper was clipped from a corner, the point was on the opposite corner of a rectangle with 2 cm width and 5.5 cm length. When the experiments were carried out in the setup of connecting the papers on these points weakly to a prong, not only an undertone was detected on the record results but also a harmonic series of the undertone frequency was created too (Fig. 5).

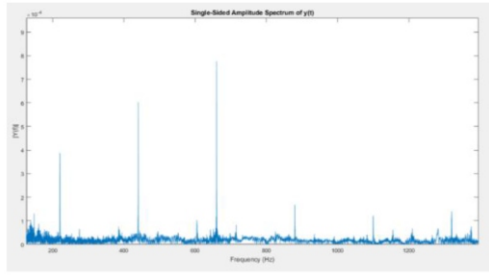
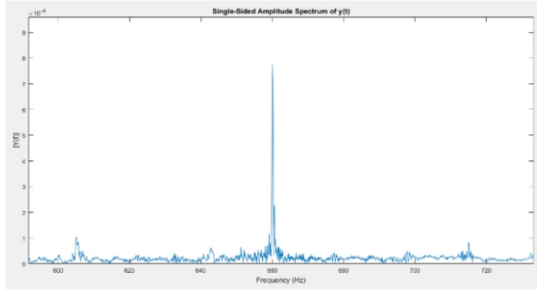
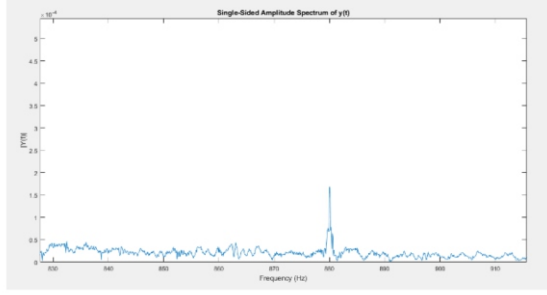


Fig. 5: Frequency plot showing the harmonic series of the undertone in experiment with paper connected in specific points

As shown earlier, the undertone that we got from our tuning fork was 220 Hz. The frequencies 660 Hz, 880Hz and 1100 Hz, can be overtones of 220 Hz. The 440 Hz, the fundamental frequency of the tuning fork, can be the overtone of 220 Hz too (Fig. 6).



(a)



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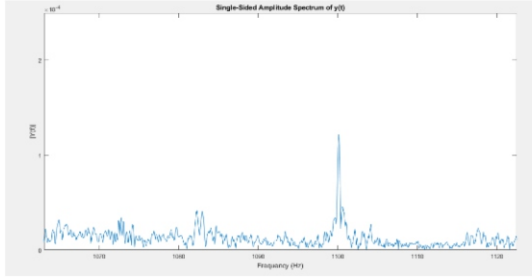

(c)

Fig. 6: Frequency plot, a) 660 Hz, b) 880 Hz, c) 1100 Hz as the overtone of 220 Hz

3 Results

In our experiments, we got the undertone sound . However, the question about the reason behind the creation of this undertone has remained unanswered. This section addresses this question.

When the prong starts vibrating, it hits the paper, which

causes the paper to vibrate. The paper starts to move back and forth on a very small scale. If the prong goes back and forth two times while the paper goes back and forth one time and they hit each other, then the sound wave made from this hit will have a frequency half of the fundamental frequency of the tuning fork. In other words, if the speed of the paper sheet becomes half of the prongs speed, an undertone with frequency half of the fundamental frequency will be made.

Next, we examine why this phenomenon only happens when we connect them in these points. Paper has different vibrating modes, depending on where, how, and with what force is hit. Whether the paper is clamped or not, and the place of the clamp are important factors since they affect the vibration. When the paper is connected weakly to the prong from those points and hit the prong there, it vibrates in a way that its speed is half of the prong's speed. So the undertone will be made.

4 Conclusion

This paper presents research investigating a physical phenomenon. We explored different conditions to create undertone using a tuning fork. The results show that with a paper sheet and a tuning fork, one can create a special situation where an undertone sounds with half of the tuning fork's natural frequency, can be heard. Our investigation shows that not only a tuning fork can create an undertone, but also we can have harmonic of the created undertone. This undertone sound can only be made when we connect the paper weakly to one of the prongs from several specific points.

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SUSPENDED WATER WHEEL

Mahla Soukhtanloo, Mashhad, Iran , mhl.skhtanloo@gmail.com

ARTICLE INFO

Winner of Gold Medal , IYSIE 2019, Malaysia

Accepted in country selection by Ariaian Young Innovative Minds Institute , AYIMI

http://www.ayimi.org ,info@ayimi.org

ABSTRACT

The problem “Suspended water wheel” investigates about the behavior of a light object which, if you release it near the edge of water that is upward, you would see that it will start to rotate and also, remain stable at a level where its weight and the water momentum equal to each other. It can be concluded that changing some parameters are responsible for different set of acts for this phenomenon.

1 Introduction

The suspended water wheel concerning a light object (ball, disk, …) that by approaching the object to a stream line of water which is opposite of gravity force, it would start to spin and oscillate (Fig.1). Under certain condition this phenomenon has the stable position. There are many factors which can change its manner and are explained in two parts, theories and experiments.

The main reason which this phenomenon happens and the object stick to the water and doesn't fall down is the adhesion force. When we close the object to the water, the adhesion which exist between the water and object's surface, makes the drops of water to go around the object and makes it spin therefor by spinning the object, it becomes stable.

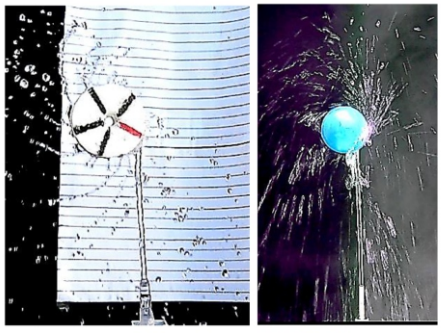


Fig.1: The structure of to show this phenomenon

2 Theory and Methods

2-1 Theoretical part

In order to explain the theories which related to this phenomenon, first we should analyze the applied forces and introduce the free body diagram (Fig.2). According to it, we have a gravity force downward which pulls the object down, the water momentum upward which pushes the object out and the adhesion force, tangent to the object which makes the object to spin.

There are some factors which help us to understand this phenomenon better and also find equations.

1. **Adhesion**, which is the tendency of particles attach to each other . This factor is the main parameter which can change the phenomenon's behavior.
2. **Angular velocity**, can be defined as the range of angular displacement. It changes as the change of some parameters and effects on phenomenon's stability.
3. **Linear momentum**, which is the systems mass multiplied by its velocity.
4. **Volumetric flow rate** that is the volume of fluid which passes per unit of time.

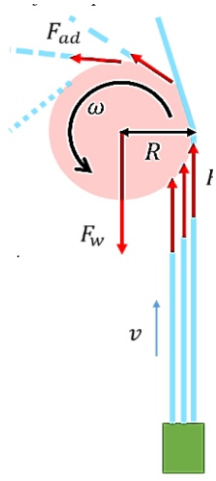


Fig.2: The free body diagram and applied forces

The force on a part of object, can be found by Reynolds equation (Eq.1) [1].

$$\frac{\delta}{\delta t}N = \frac{\delta}{\delta t}\int \eta\rho d\forall + \int \eta\rho\vec{v}.d\vec{A} \quad (1)$$

where $\eta = \frac{N}{m}$ which if we want to write this equation for the momentum, we should equal N to the P=mv .

We have a pressing force which is applied to the surface and we have a body force as weight which is written in any vector direction.(Eq. 2-4).

$$f_{sx} + f_{Bx} = \int u\rho\vec{v}.d\vec{A} \quad (2)$$

$$f_{sy} + f_{By} = \int v\rho\vec{v}.d\vec{A} \quad (3)$$

$$f_{sz} + f_{Bz} = \int w\rho\vec{v}.d\vec{A} \quad (4)$$

In these equations f_s is the surface force and f_B is the body force that, their summation would give us the total force, on the other hand in this phenomenon the mass of the water drops are very low and ignorable, so by ignoring the body force we can have the surface force on object.

By using the equation (3) in y direction with negative sign for inlet flow which water with v hits the ball from part A (Fig. 3) and also with positive sign for the outlet flow which their difference would give us the applied force to the object.

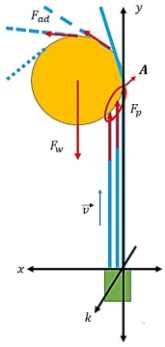


Fig.3: The free body diagram for the surface force

3 Experiments

There are many parameters that can effect on the phenomenon so in order to perform these experiments and have least errors main base (pipe, pump, …) which water could get out of it, with different nozzles and objects are used (Fig.4).

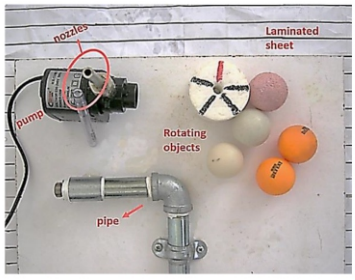
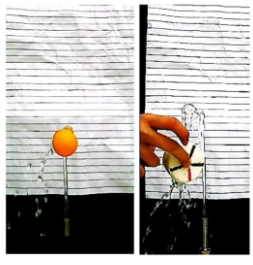


Fig. 4: Experimental setup

By recording a video and analyzing with Tracker the affected parameters on the stability are investigated. These parameters are Flow Rate , Weight , Warer Jet Nozzle and Surface Properties .

3-1 The Effect of Flow Rate

Disc and ball are used to find how they act by changing the flow rate. In our experiment ball stands and spin on water jet but it doesn't work on the disc in first step with a low flow rate (Fig. 5).



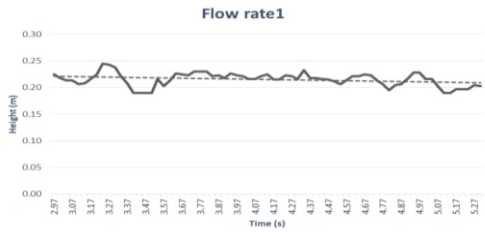
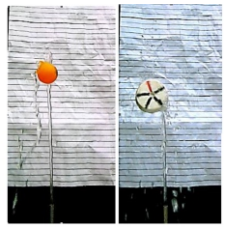


Fig. 5: First step flow rate, acting on the ball and disc

In the next posture of flow rate, we increase the velocity more than before and as the charts show ball got more vibration (Fig.6) .



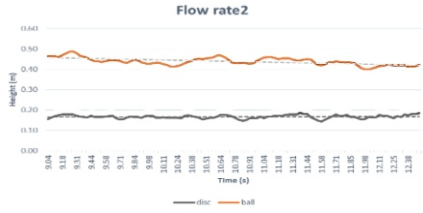
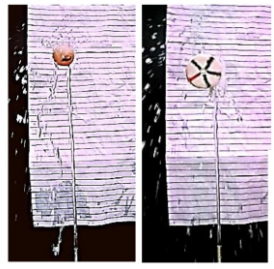


Fig. 6: Second step flow rate, acting on the ball and disc with more velocity

In the third posture, we can see by increasing more the flow rate , the turbulence that exist in lines of the water would also increase so the ball would has more oscillation than disc in our experiment (Fig.7).



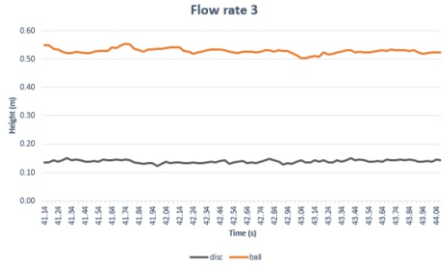


Fig. 7: Third step with higher flow rate, acting on the ball and disc

3-2 The Effect of the Weight of Object

Another experiment which somehow relates to the pervious one is the weight. It is so clear that by increasing the mass of the balls or discs, the power of water cannot handle the object overall so the greater the mass, the lower the height which would cause to fall down (Fig. 8).

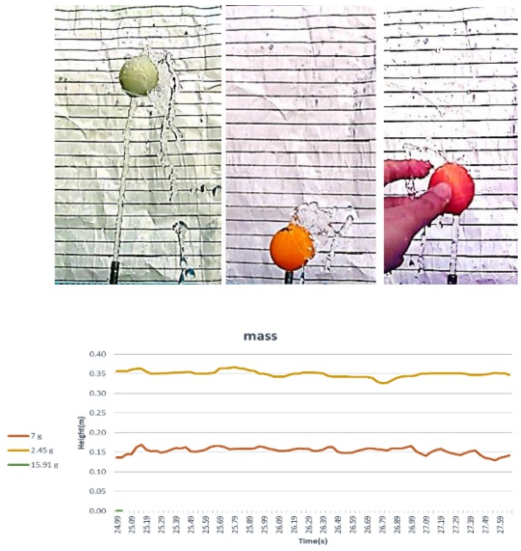


Fig. 8: Objects with different masses

3-3 The Effect of different Nozzles in Water jet

For this experiment at first a 3.5 *mm* nozzle was used for both the ball and disc. This nozzle was small so the extracted backwater was also thin. It is observed that water cannot contain the ball inside of itself and makes it to go up and down so it make the ball to have lots of oscillation and makes the disc to have the stable posture (Fig.9).

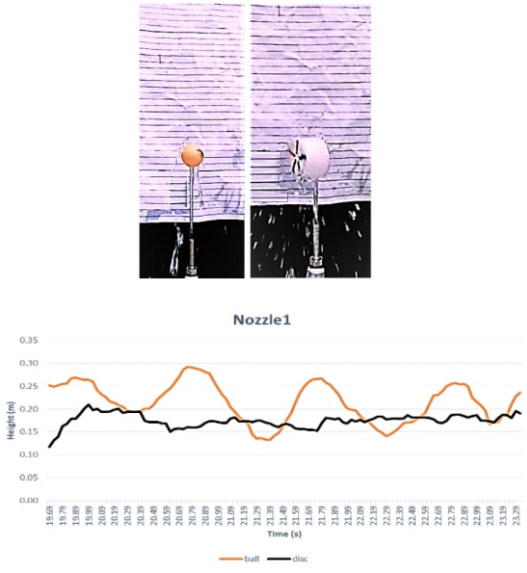


Fig. 9: The ball and disc on water jet with a small nozzle(3.5*mm*)

The second part was by a 5.5 *mm* nozzle which the ball has the ideal position for this nozzle because the volumetric flow rate is more so water can surround the ball better (Fig.10).

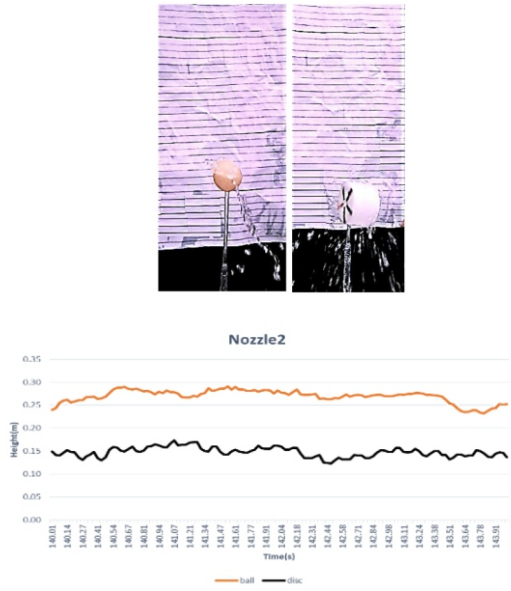


Fig. 10: 5.5 *mm* nozzle

3-4 The surface properties

This parameter has the main effect on this phenomenon . As the first posture a clean ball that actually had the best result was used and then it was covered with sand, which, due to the ripples, caused the water droplets to flip over to one side and makes lots of vibration and makes it unstable (Fig.11) [2].

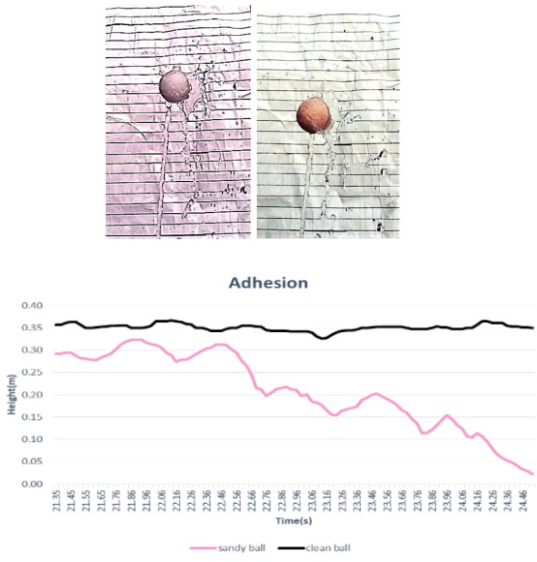


Fig. 11: Two balls with different surfaces

The next experiment was with a disc and a ball were covered by oil which both of them weren't stable at all because oil prevents the water from sticking to the objects' surface to make them spin (Fig.12).

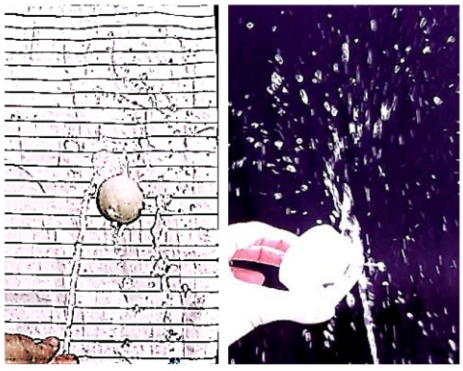


Fig.12: An oily ball and disc

4 Results and discussions

According to the experiments and the results obtained, let's talk about the best position for this phenomenon:

1. Flow rate: The important thing about this parameter is that the used water jet should be so powerful to handle any kind of object (Fig.13).

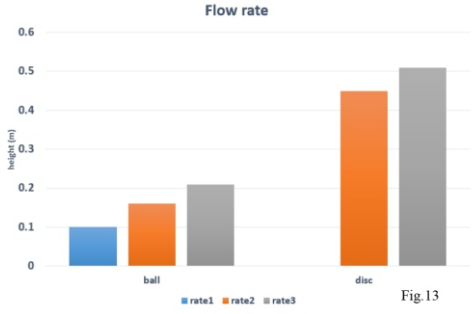


Fig.13: The effect of flow rate on ball and disc

2. Weight: It is too important to use an object that is as light as possible (Fig.14) .

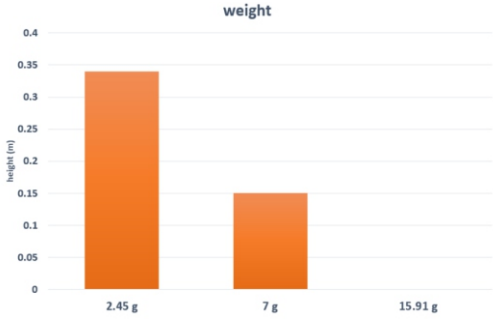


Fig.14: The effect of different masses

3. Water jet nozzle: This parameter relates to the object which if the used nozzle is small is better to use disc and if the nozzle is bigger, it's better to use ball (Fig.15).

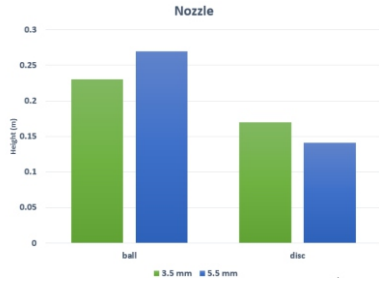


Fig.15: The effect of different size of water jet nozzles

4. Surface properties: this parameter has the main effect on this phenomenon. The object should be so clean, without any external covers on its surface in order to see the best results (Fig.16).

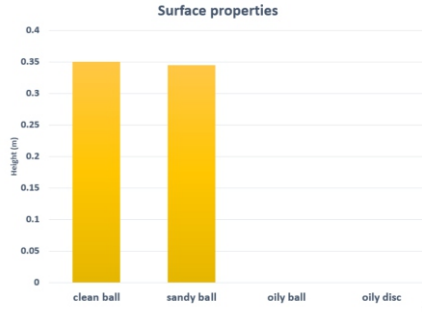


Fig.16: The effect of surface properties

5 Conclusions

The suspended water wheel express the manner of a light object that placed near the edge of water stream. We could analyze this phenomenon by Reynolds transport equation to find the force that is applied to a part of the object surface. Flow rate, weight of the objects, water jet nozzles and surface properties were investigated in this phenomenon. In use of the ball and disc in all experiments the stability of objects was examined which the ball is more stable than the disc.

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[2] Srinivas ,VL, (2018), "Can you explain Veritasium's Hydrodynamic levitation or Fluid Juggling ? researchgate.net, https://www.researchgate.net/post/

TORNADO SPHERE

Armina Daraei, Farzanegan 5 High School, Tehran/Iran

ARTICLE INFO

Winner of Bronze Medal , ICYS 2019, Malaysia

Supervisors: Dr. Hossein Salari, & Dr. Kasra Farain

Accepted in country selection by Ariaian Young Innovative Minds Institute , AYIMI

http://www.ayimi.org ,info@ayimi.org

ABSTRACT

In this research we are going to investigate a phenomenon which two joined steel balls together are spinning at incredibly high frequency. Their first spinning is by hand and then blowing on them through a tube, e.g. a drinking straw. There are relevant parameters such as , ball diameter, velocity of blowing and surface friction.

(This is a short explanation)

1 Introduction

Hurricane balls are a simple spinning toy formed of two steel balls welded together. When spun by hand on a smooth surface with little friction, the spin rate can be significantly increased by blowing on the edge of one of the balls through a tube (e.g. a straw). The movement of hurricane balls has three steps: 1.rising 2.speeding 3.steady, that in steady-state situation, the double-sphere rolls without slipping during its motion. Also one of the balls separates from the table so it has an angle with horizontal axis [1].

2 Theory and Methods

To calculate the angel, we need to calculate the potential and kinetic energy, and then with lagrangian approach we'll find θ (angle) according to angular velocity [2].

$$\frac{d}{dt}\left(\frac{\partial L}{\partial \dot{\theta}}\right) - \left(\frac{\partial L}{\partial \theta}\right) = \frac{\partial L}{\partial \theta} = 0$$

$$\theta = 90 \rightarrow I_3\ddot{\theta} = 2mgr - I_1\dot{\psi}\dot{\phi}$$

$$\ddot{\theta} > 0 \rightarrow 2mgr > I_1\dot{\psi}\dot{\phi}$$

$$\rightarrow \dot{\psi}\dot{\phi} > \frac{2mgr}{I_1}$$

3 Experiment

We used two ball bearings and joined them together (with glue) (Fig. 1), so we had constructed double-spheres of different sizes. The distance between two ball bearings was other parameter which we used three and four balls between our main balls to have different distances. Then we recorded their motion using a camera, 240 frames per second. At last we analyzed our videos using video analysis program tracker , then by blowing in a tube we got the time, θ and number of frames around the axis of the rotation with tracker until the end of the video (when θ is zero) (Fig.2)

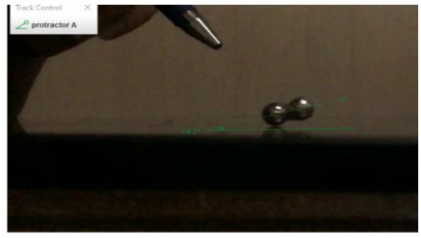


Fig.1: Blowing with a tube to see rolling of the hurricane ball

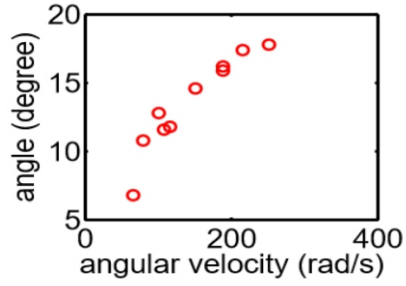


Fig. 2: The angle from the surface according to the angular velocity (d=1cm)

4 Results and Discussion

At last as a general result, we found:

- As the angular velocity increases, the angle (θ) increases with horizon.
- There is a minimum angular velocity that if (***ω***)is less than that, the phenomenon doesn't occur.
- We have maximum θ too.

References

[1] Brett J. , Mertens, P D, Jackson, D P (2015), " Hurricane Balls: A Rigid-Body-Motion ". Project for Undergraduates.

[2] Walker,J, Halliday & resnick(9th edition).

Multichannel Pipette with the Ability of Transferring Various Amounts in Each Channel

Maneli Iranmanesh , Farzanegan 1 High School, Tehran, Iran, Maneliiranmanesh2001@gmail.com

ARTICLE INFO

Winner of Bronze Medal , IYSIE 2019, Malaysia

Accepted in country selection by Ariaian Young Innovative Minds Institute , AYIMI

http://www.ayimi.org ,info@ayimi.org

ABSTRACT

Micro pipettes are utilized in laboratories for transferring different amounts of liquids varying from 0.1 to 1000 µL. The most common science fields that they are being used includes biology, chemistry pharmaceutical, and drug discovery labs, and etc. Multichannel is 8 or 12 channel micro pipettes that mostly used to fill wells of micro plates which are available in various sizes. In this project a multichannel has been built with the ability of transferring various amounts in each channel.

1 Introduction

Micro pipettes were invented and patented in 1957 at University of Marburg, Germany by postdoc Heinrich Schnitger (Fig. 1). The protype included a spring-loaded piston and a removable plastic tip for containing liquid[1].

Fig. 1: Schnitger`s protype

They can function either via air displacement or by positive displacement principles. In air displacement, an air cushion separates the liquid in the plastic tip from the piston in the pipette. As with any gas, air cushion changes according to the liquid`s characteristics, depends on lab or protocol conditions (temperature variation, or humidity). With positive displacement principle, a piston replaces the air cushion and slides along the internal sides [2].

Micro pipettes are the easiest way to increase your output and efficiency, while reducing assay, testing and production costs at the same time. This device will reduce the hours consumed by pipetting and thus, the risk of repetitive strain injury (RSI) will decrease as well. Reducing RSI can save your lab costs by preventing slower pipetting or even the shutdown of the operation due to injury. The ability to pipette 8 or 12 samples or dispense reagents into 8 to 12 wells at a time is hugely beneficial when performing assays involving enzymatic reactions, where liquid handling speed, as well as accuracy, is key.

Polymerase chain reaction or PCR is technique that is used to make many copies of specific DNA. As the results, Multichannel is more useful and efficient in assays using this technique.

2 Methods and Materials

The MTT assay is a colorimetric analysis for assessing cell metabolic activity. An enzyme-linked immunosorbent assay, called ELISA or EIA, is a test that detects and measures antibodies in your blood which is a protein that your body produces in respond to harmful substances called antigen [3]. In those and other enzymatic assays, the transferred amounts should be different in each micro plate's well and using a micro pipette is not a choice here because it will cost 8 to 12 times more time to fill a 96 micro plate than using a multichannel pipette. It will also decrease testing and production. Using a multichannel pipette is also not an answer because of the same amount distribution in each channel.

Accordingly, creating a multichannel pipette which transfers various amounts of liquid in each channel was decided. The implanted mechanical plan contains of at least three micro pipettes which are put next to each other in a multichannel pipette case (Figs. 2 and 3).

Fig. 2: Three Micro pipettes

Fig. 3: The Multichannel case

The useless parts should be removed for a better perspective of the display. A lever that is mainly built from screws, nuts, rods, and a handle was applied at the bottom of the three micro pipettes, making it able to push them all down at the same time. To solve the issue of the distances between the tips (which is the standard distance of 4.5mm in multichannel pipettes), a plastic hose was put to use. At the bottom, a spring is embedded as a tip ejection key (Figs.

4 and 5).

Fig. 4: Removing useless parts

Fig. 5: Applied plastic hose

3 Conclusion

Here is an evaluation we did using a Growth medium (Table 1) (Fig.6).

Table 1 : comparison of micro pipette and multichannel

Properties	micropipette	The discussed multichannel pipette
Filled wells	6	6
Time span	57 seconds	9 seconds
Times to change the quantity	6	1

Fig. 6: Various transferred volumes

References

[1] Martin Klingenberg, (2006), The original micropipette, https://www.the-scientist.com/foundations-old/the -original-micropipette-48026

[2] Gilson, (2017), How positive displacement pipettes work, https://www.labmanager.com/how-it-works/2017/06/how-positive-displacement-pipettes-work#.Xc26JOgzbic.

[3] Trica Kinman, (2017), ELISA, http://www.healthline .com/health/elisa.

HANGING ELEVATOR

Ariyan Mirzaee, Sama School, Mashhad, Iran, Mirzaeeariyan@gmail.com

ARTICLE INFO

Winner of Gold Medal in IYSIE2019,Malasiya

Accepted in country selection by Ariaian Young Innovative Minds Institute , AYIMI

http://www.ayimi.org ,info@ayimi.org

ABSTRACT

Hanging Elevator is a system which stop the elevator from falling and crashing. The main purpose of this project is to find a way to stop elevator from falling. The cable of elevator that hold the elevator may rupture; if it ruptures , the elevator will fall down and crash and causes damages. Hanging Elevator is basically related to the phenomenon that we called it “Looping Pendulum”. In this research we are going to investigate the parameters which affect this experiment and what relations between this parameters cause a better result in an ideal system.

1 Introduction

The Hanging Elevator is a system which stops the elevator from falling and crashing which is basically related to the phenomenon that we called it 'Looping Pendulum' [1]. Based on Looping Pendulum, when we connect two loads, one heavy and one light, with a string over a horizontal rod and lift up the heavy load by pulling down the light one and by releasing the light load and it will sweep around the rod, keeping the heavy load from falling to the ground [2]. To find an ideal system , several experiments are done and the parameters which affect these experiments are investigated.

2 Methods and Modeling

For Hanging Elevator, we designed a structure as our main system that gives us the least errors . There are 3 steps for this structure. First, we put bar with 10 mm radius on the flat surface; then for measuring the angle of extrication, we design a protractor and locate it in front of the axis. Third for connecting the weight and wooden elevator (maquette), we use a woolen string. Finally for weight, we use metal weights with specific masses (Fig. 1).

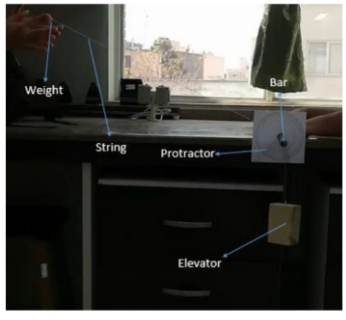


Fig. 1: : Experimental Setup

3 Theoretical Analysis

A light load (m_1) is connected to a heavy load (m_2) with a string that its length is L. The system is over a horizontal rod of radius r .As you can see in Figure (1), a coordinate system is attached to the origin of the rod while its *x* axis is in the horizon direction. The length of the string is decomposed in three parts; *s* is the distance from light object to the first contact point of string with rod, *l* is the length of string in contact with rod, *H* is the distance from heavy load to the contact point with rod and assuming rigid string, the equations are written(Eq. 1-8)(Fig. 2).

$$L=s+l+H \qquad l=r\,\phi \qquad \phi=\frac{\pi}{2}+\theta \tag{1}$$

$$\vec{R}_1 = r\,\hat{r}+s\,\hat{\theta} \tag{2}$$

$$\vec{V_1} = \dot{R}_1=(r\dot{\theta}+\dot{s})\hat{\theta} - s\,\dot{\theta}\,\hat{r} \tag{3}$$

$$\vec{a}_1 = \ddot{R}_1 = (r\ddot{\theta}+\ddot{s} - s\dot{\theta}^2)\hat{\theta} - (r\dot{\theta}^2 + s\ddot{\theta} + 2\dot{s}\dot{\theta})\hat{r} \tag{4}$$

$$W_2 \sin\theta - T_2 = m_2(r\ddot{\theta} + \ddot{s} - s\dot{\theta}^2) \tag{5}$$

$$W_2 \cos\theta = m_2(r\dot{\theta}^2 + s\ddot{\theta} + 2\dot{s}\dot{\theta}) \tag{6}$$

$$W_1 - T_1 = m_1\ddot{H} \Longrightarrow W_1 - T_1 = -m_1(\ddot{s} + r\ddot{\theta}) \tag{7}$$

$$T_1 = T_2 e^{\mu\varphi} \tag{8}$$

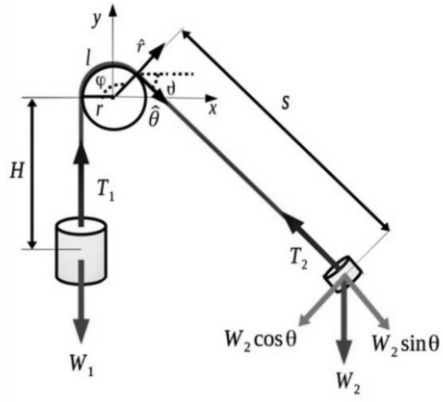


Fig. 2: Free body diagram

According to free body diagram and equations, there are 4 forces acting on the light mass (m_1) that contain Gravitation force [3], Centripetal force [4], Tension force [5] and Coriolis force [6] as following equations (Eq. 9-12) (Fig.3).

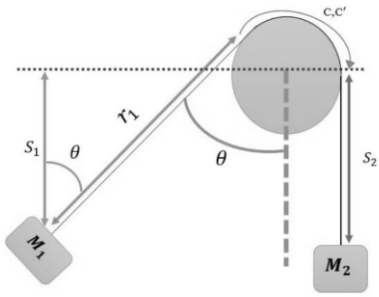


Fig. 3: Free body diagram of forces acting on masses

$$\left.\begin{aligned} l &= c + r_1 + r_2 \\ 0 &= 0 + \dot{r}_1 + \dot{r}_2 \\ 0 &= \ddot{r}_1 + \ddot{r}_2 \end{aligned}\right\} \text{(1)} \tag{9}$$

$$\left.\begin{aligned} l &= C' + S_1 + S_2 = C' + r_1\cos\theta + S_2 \\ 0 &= 0 + \frac{d(r_1\cos\theta)}{dt} + \dot{S}_2 \end{aligned}\right\} \text{(2)} \tag{10}$$

$$\left.\begin{aligned} &\frac{d(r_1\cos\theta)}{dt} = \dot{r}_1\cos\theta - r_1\dot{\theta}\sin\theta = \\ &\ddot{r}_1\cos\theta - \dot{r}_1\dot{\theta}\sin\theta - \dot{r}_1\dot{\theta}\sin\theta - r_1\ddot{\theta}\sin\theta - r_1\dot{\theta}^2\cos\theta \end{aligned}\right\} \text{(3)} \tag{11}$$

$$\blacksquare\ 1, 2, 3 \Rightarrow$$

$$\ddot{S}_2 + \ddot{r}_1\cos\theta - 2\dot{r}_1\dot{\theta}\sin\theta - r_1\ddot{\theta}\sin\theta - r_1\dot{\theta}^2\cos\theta = 0 \tag{12}$$

Then T_1, T_2 and $\ddot{S}$ are found (Eq. 13-18).

$$m_1 g\cos\theta - T_1 = m_1(\ddot{r} - r\dot{\theta}^2) \tag{13}$$

$$-m_2 g\sin\theta = m_2(2\dot{r}\dot{\theta} + r\ddot{\theta}) \tag{14}$$

$$m_2 g - T_2 = m_2\ddot{S}_2 \tag{15}$$

$$T_1 = \frac{2m_1 m_2 g}{m_1 e^{\mu\varphi} + m_2\cos\theta} \tag{16}$$

$$T_2 = \frac{2m_1 m_2 g e^{\mu\varphi}}{m_1 e^{\mu\varphi} + m_2\cos\theta} \tag{17}$$

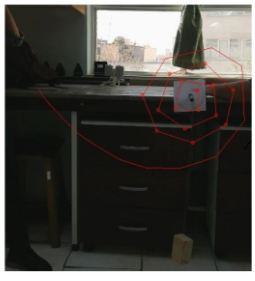
$$\ddot{S} = \frac{m_2 g\cos\theta - m_1 g e^{\mu\varphi}}{m_1 e^{\mu\varphi} + m_2\cos\theta} \tag{18}$$

Now by solving these equations :

4 Experiments and Results

In our experiment(Fig. 4), effective parameters that were investigated are :

1. Mass ratio
2. The angle of extrication
3. The length of extrication
4. Friction between string and bar



Fi. 4: Experiments to find effective parameters

4-1 Mass Ratio and Angle of Extrication

Mass ratio is increased from 1 to 10 , then we investigate each proportion at 5 angles which the best one is (Fig. 5):

$$\frac{M_2}{M_1} = 10$$

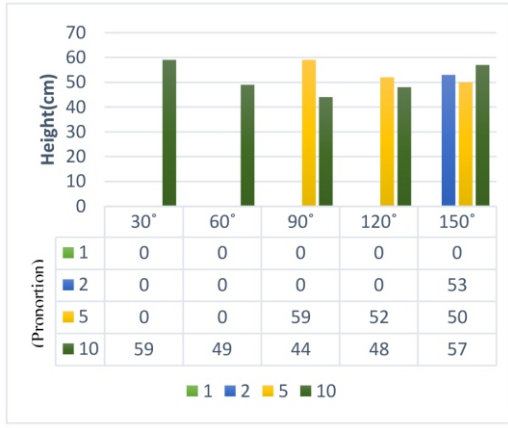


Fig. 5: Mass ratio versus the angle of extrication

4-2 The Height of Extrication

To find the height of extraction, experiment was done at 5 angles and specific mass ratio. A string with a constant length is used which 3 sections are marked on it(Fig. 6).

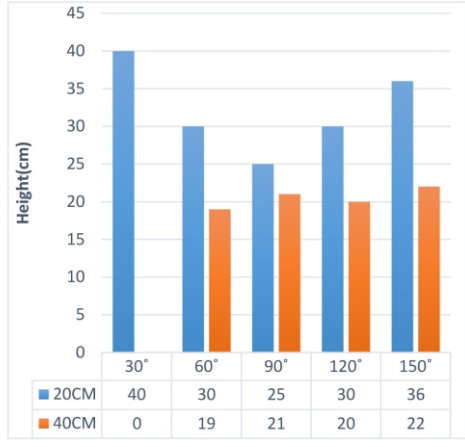


Fig. 6: The height of extrication in different angles

4-3 The Friction Between String and Bar

Six types of surface , paper, banderole, aluminum, cloth, bar and oily surface are used to find the affection of friction in our experiments (Fig. 7).

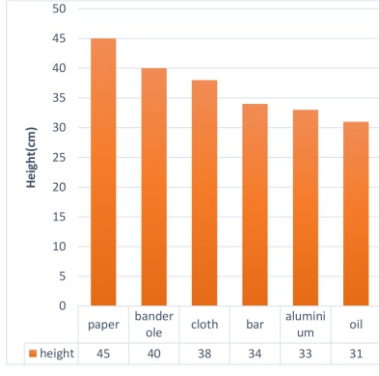


Fig. 7: Different heights in different surfaces

5 Results and Conclusions

By several experiments in this phenomenon, tension of string and acceleration of the elevator were found. Some effective and main parameters are found by tracking the motion of light and heavy loads. The best state is when the mass ratio is 10 and it's in 120˚. Also the friction between bar and string is important parameter which should be considered.

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INTERNATIONAL CONFERENCE OF WOMEN IN PHYSICS, ICWIP 2019-2020

Travel Grants for Women in Developing Countries Gillian Butcher (Chair, WG5) and Silvina Ponce Dawson (Vice-President at Large (Gender Champion))
(IUPAP Newsletter 2019)

Attending international conferences is a crucial part of any physicist's career development, sharing results, learning about new developments and making valuable connections. However, as was highlighted by Ivie [ref] women are not so likely to access travel funds, particularly in developing countries: 31% of women from developing countries said they had access to travel funding compared with 64% of men from highly-developed countries.
Since its creation in 2002, WG5 Women in Physics has been tasked with administering IUPAP travel grants to women from developing countries who wish to attend conferences. It is interesting to note that in the 18 years of funding, over 400 grants have been distributed to applicants in 53 countries.

Impressive as those statistics are, it is the effect that these grants have on individuals that is most telling. We have here the statement by a female researcher from Argentina who received a travel grant at a time when Argentina was facing very bad economic conditions and the support for science was practically non-existent:
"Even if the award is relatively modest, it is very good for a starting point. It helped me a lot. I've got it in 2002, when the economic situation in my country (Argentina) was horrible, there were no openings for scientific jobs, I had just finished my postdoctoral fellowship. With the grant, I went to an international congress in Brazil and started collaborating with experimentalists from Porto Alegre and Rio de Janeiro that lasted many years with me working in Argentina and traveling every now and then to visit them (that was very hard for me with 4 little kids). That kept my scientific career "alive" for a while until the situation in Argentina improved."
Ref: R. Ivie, C. Langer Tesfaye Women in Physics: A tale of limits
Physics Today (Feb 2012)

ICWIP 2020 in Melborne, Australia

IUPAP Working Group members (Wg5) in physics had a meeting with Australian organizing committee as LOC in July 22-25, 2019 at Melborne university , physics department. All the programs about ICWIP 2020 were discussed during this meeting . Now all the teamleaders from different participant countries are invited to prepare their country reports in physics activities during three years before this conference .
Those who are interested may send their scientific abstracts directly to the conference too.
All details about 7th IUPAP International Conference of Women in Physics, ICWIP , July 13-17, 2020:
https://wp.csiro.au/icwip2020/

WG5: WOMEN IN PHYSICS

Working Group 5 (Wg5), Women in Physics (WiP), was created by the International Union of Pure and Applied Physics in 1999 as a resolution of the Atlanta, Georgia, USA General Assembly to survey the present situation and report to the Council and the Liaison Committees, and to suggest means to improve the situation for women in physics.

Charge to Working Group
to survey the situation for women in physics in IUPAP member countries;
to analyse and report the data collected along with suggestions on how to improve the situation;
to suggest ways that women can become more involved in IUPAP, including the Liaison Committees, the Commissions, the Council, and the General Assemblies;
to report all findings at the General Assembly in 2002.
In carrying out the above charge, it may prove useful to organise and convene an international meeting on women in physics. If such a meeting occurs, it should be planned so that a full account can be provided with the report at the General Assembly in 2002.

Members
Chair: Gillian Butcher
Vice Chair: Lilia Meza Montes
Kwek Leong Chuan
Shohini Ghose
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