İZMİR KÂTİP ÇELEBİ UNIVERSITY
2010

MEE203 - DYNAMICS LECTURE
PROJECT REPORT

PROJECT NAME: *“PLACE,SHOOT,BASKET!”*

GROUP NUMBER AND NAME: *4 - WHALES*

DATE: *03.12.2021*

WHALES

GROUP MEMBERS

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I. AIM OF THE PROJECT

The purpose of the project is to understand the application of theoretical knowledge seen in the dynamics course in real life. At this point, Project will be provided by using the projectile motion and rigid body system calculations. In the project, an object will enter the hollow cube, as well as the cube will move from one point to another point.

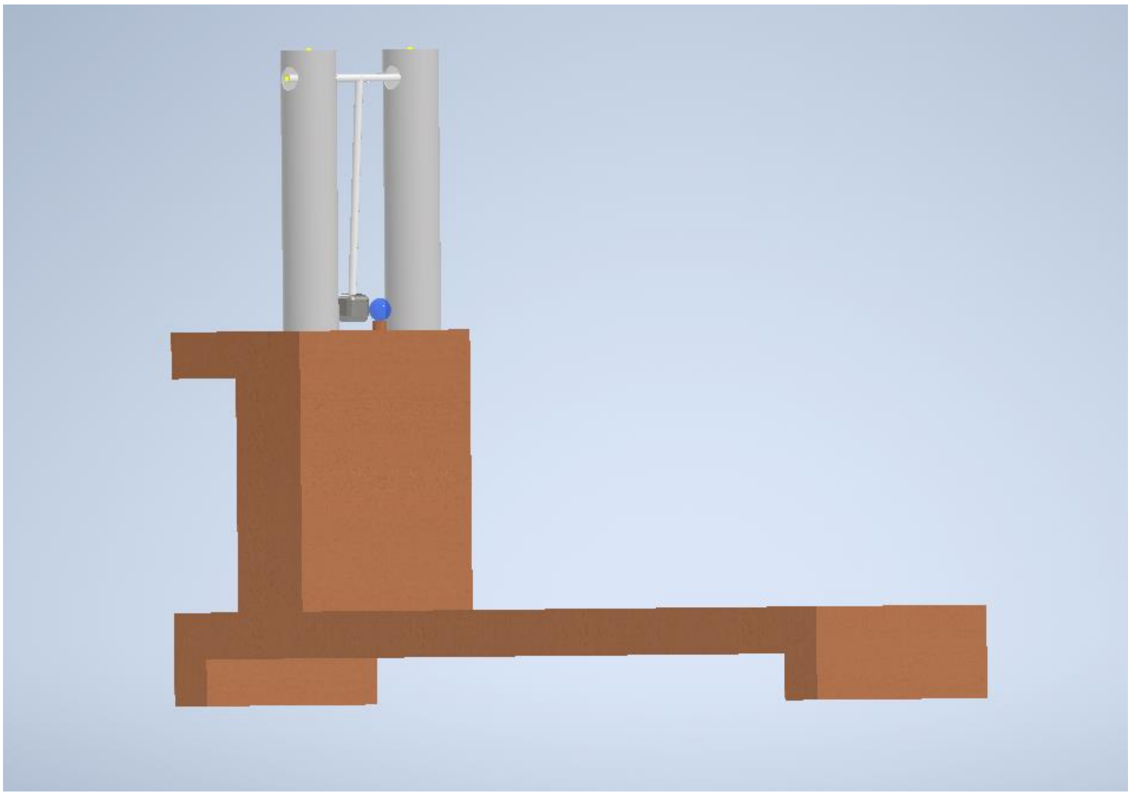
II. METHOD

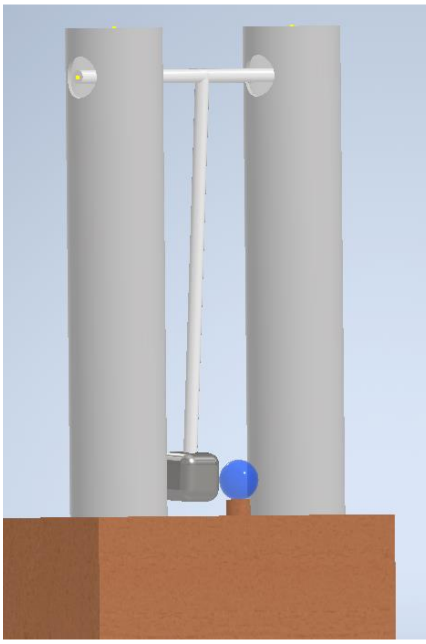
In the project design, the system is created and calculations are made by considering impulse-momentum and mechanical energy transformation. The design consists of a hammer and ball assembly. The hammer has a certain potential energy, taking a position at a height of 25 cm at an angle of 90 degrees. The hammer, which will start its downward circular movement under the influence of gravity, hits the ball that is in static equilibrium and transfers its energy using the principle of momentum. Thanks to this, the ball initiates the movement of projectile motion.

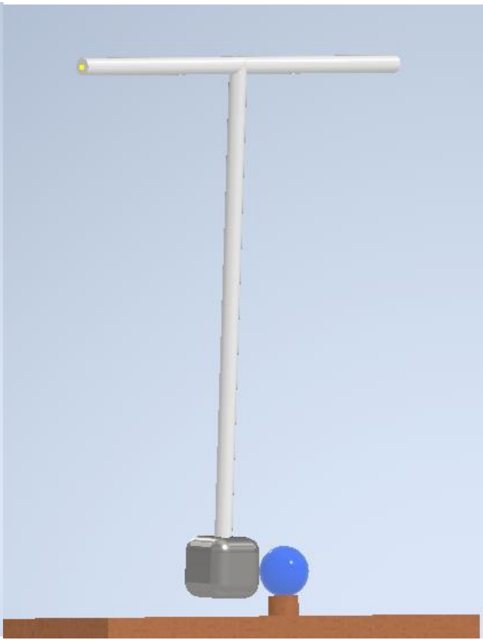
The glass ball that starts the projectile motion, also takes a certain path in the horizontal direction and enters the hollow cube with the duration of the movement that it will continue in the vertical direction.

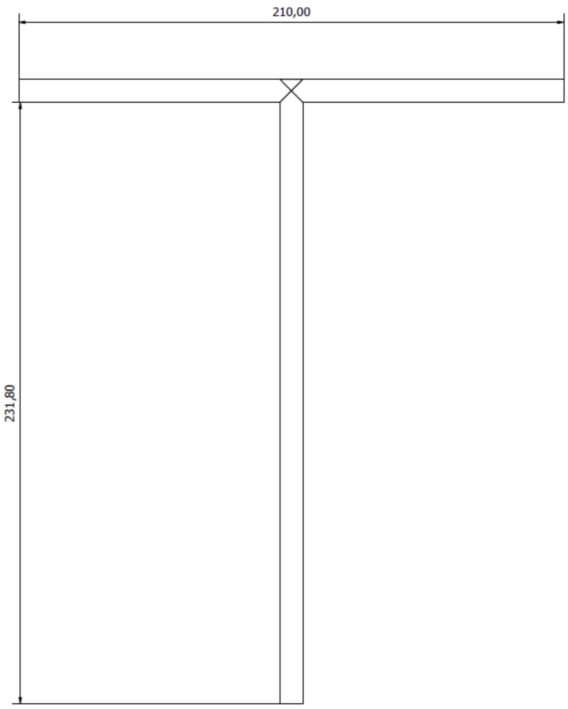
When creating the intended design, it is calculated based on the impulse-momentum, mechanical energy conservation and projectile motion formulas.

a) TECHNICAL DRAWINGS





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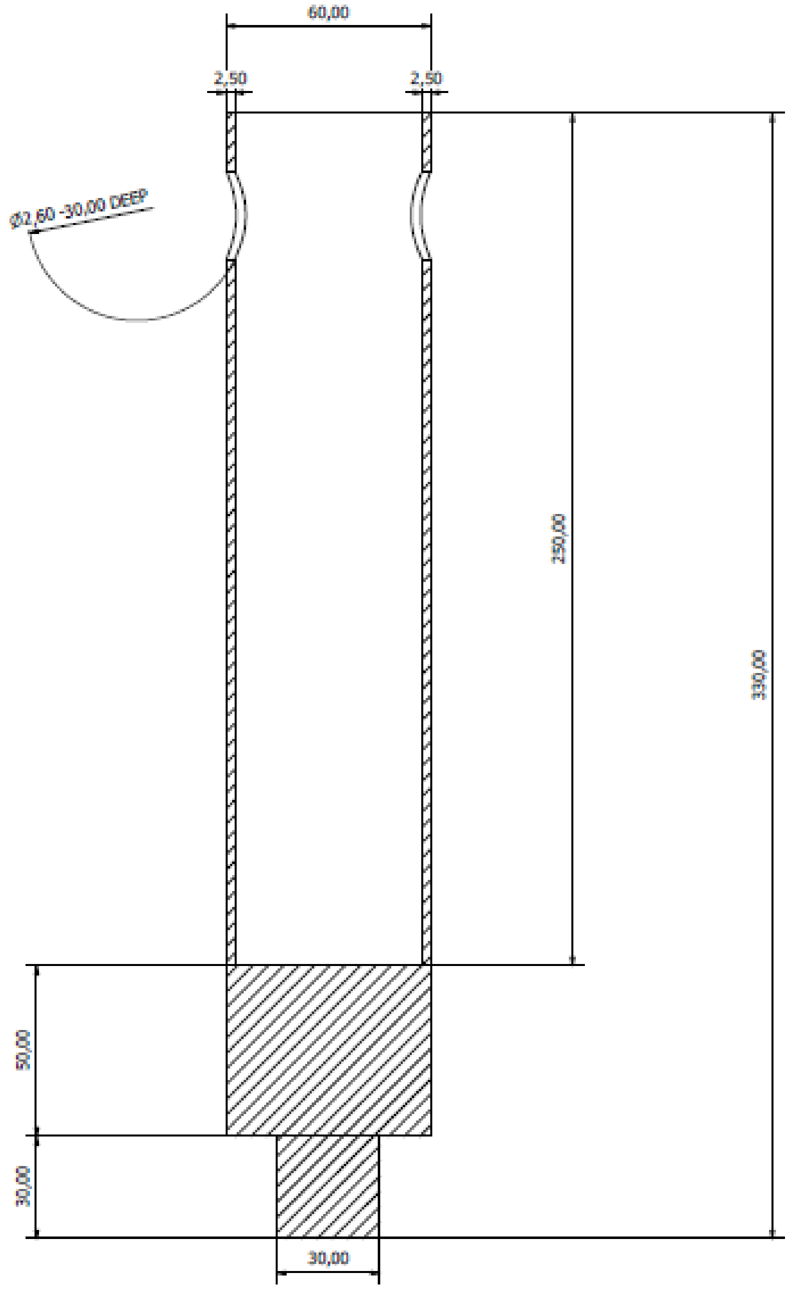
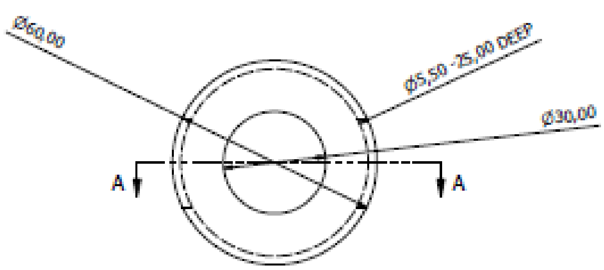
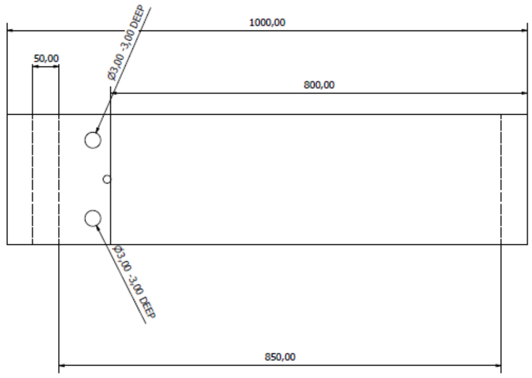
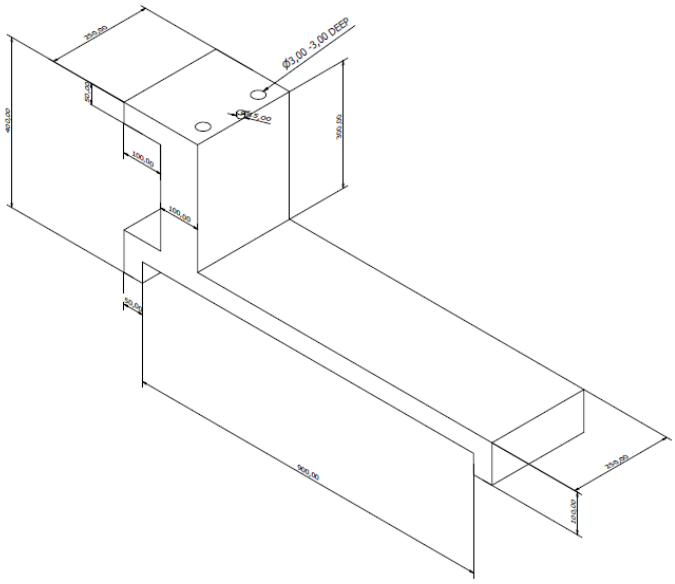
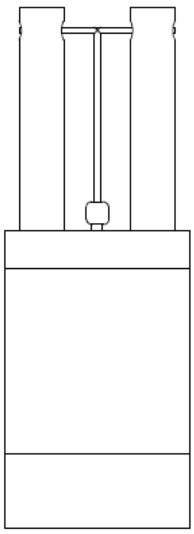


SECTION A-A
SCALE 1 : 1

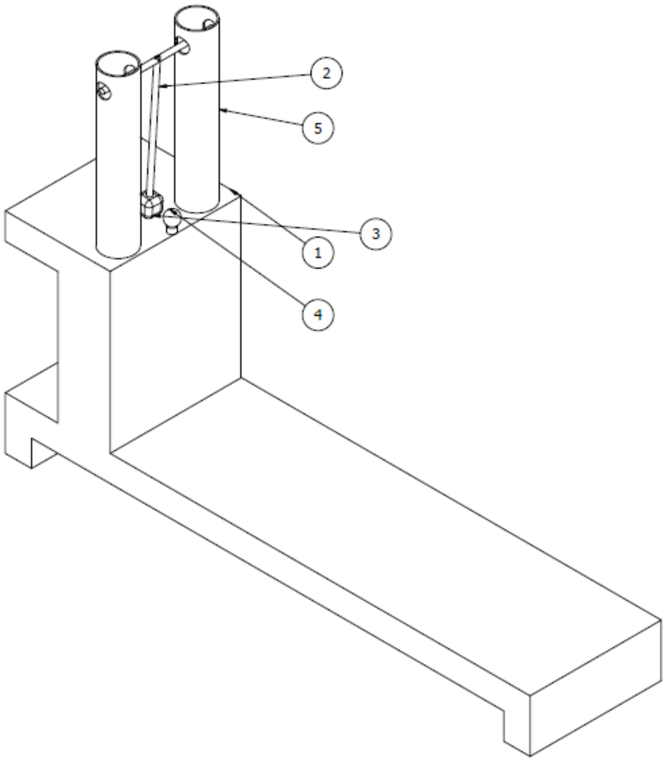


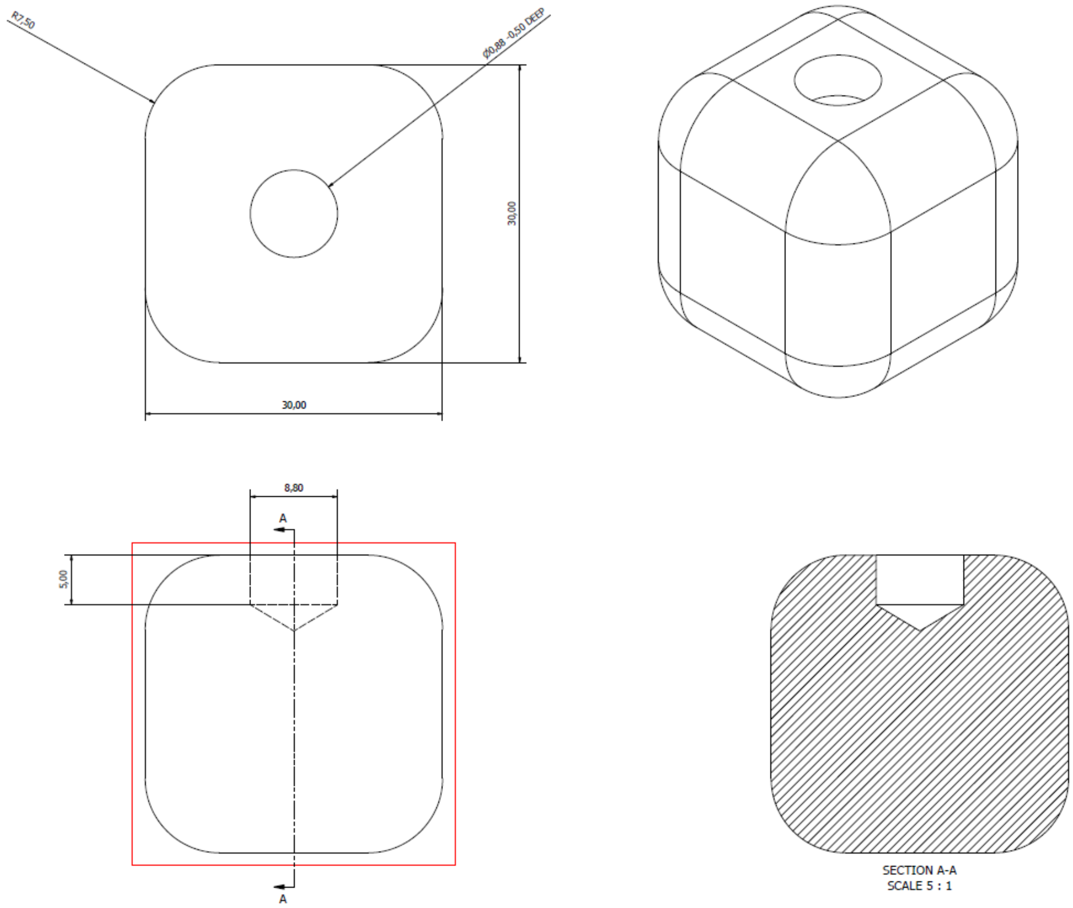






PARTS LIST			
ITEM	QTY	PART NUMBER	DESCRIPTION
1	1	Platform	
2	1	T-Shaft	
3	1	Hammer	
4	1	Marble	
5	2	Support	





b) DATA AND ANALYSIS

When obtaining data, precise scales for mass and a digital caliper were also used for radius measurements.The data may vary depending on the precision of the instrument used.

i) PROPERTIES OF THE MARBLE AND HAMMER

M_{marble} = 0.019 kg

M_{hammer} = 0.200 kg

h_{hammer} = 0.214 m

r_{marble} = 0.025 m

CR_{glass} = Coefficent of Restitution = 0.69

*The coefficient of restitution (COR, also denoted by e), is the ratio of the final to initial relative speed between two objects after they collide. It normally ranges from 0 to 1 where 1 would be a perfectly elastic collision. A perfectly inelastic collision has a coefficient of 0, but a 0 value does not have to be perfectly inelastic. It is measured in the Leeb rebound hardness test, expressed as 1000 times the COR, but it is only a valid COR for the test, not as a universal COR for the material being tested.

The value is almost always less than 1 due to initial translational kinetic energy being lost to rotational kinetic energy, plastic deformation, and heat. It can be more than 1 if there is an energy gain during the collision from a chemical reaction, a reduction in rotational energy, or another internal energy decrease that contributes to the post-collision velocity.

ii) USED FORMULAS FOR CALCULATIONS

VELOCITY AFTER IMPACT FORMULA

$$V_h = \frac{m_h v_{h0} + m_m v_{m0} + m_m C_R (v_{m0} - v_{h0})}{m_h + m_m}$$

$$V_m = \frac{m_h v_{h0} + m_m v_{m0} + m_h C_R (v_{h0} - v_{m0})}{m_h + m_m}$$

FORMULA OF ENERGY CONSERVATION FOR THE HAMMER

$$m_h g h_h = \frac{1}{2} m_h v_{h0}^2$$

PROJECTILE MOTION FORMULAS FOR MARBLE

$$y - y_0 = v_{y0} t - \frac{1}{2} g t^2$$

$$x = v_m t$$

where y is vertical position and x is horizontal position.

iii) CALCULATIONS

Air resistance is not included in the calculations.

- **DROPPING THE HAMMER**

$$(0.214)(9.81) = \frac{1}{2} v_{h0}^2$$

$$v_{h0} = \sqrt{2(9.81)(0.214)} = 2.05 \frac{m}{s}$$

- **AFTER IMPACT OF HAMMER AND MARBLE**

$$V_h = \frac{(0.200)(2.05) + (0.019)(0) + (0.019)(0.69)(0 - 2.05)}{0.200 + 0.019} = 1.75\,\frac{m}{s}$$

$$V_b = \frac{(0.200)(2.05) + (0.019)(0) + (0.200)(0.69)(2.05 - 0)}{0.200 + 0.019} = 3.16\,\frac{m}{s}$$

- **PROJECTILE MOTION OF THE MARBLE**

$$0 - 0.32 = (0)t - \frac{1}{2}(9.81)t^2$$

$$t = \sqrt{\frac{2(0.32)}{9.81}} = 0.255\ s$$

$$x = (3.16)(0.255) = 0.81\ m$$

iv) LIST OF MATERIALS

The list of materials that will be used in the design is given in the following table.

Table 4.1- PART LIST

Part Name	Material
T-Shaft	ABS – Plastic (3D printer)
Support	ABS – Plastic (3D printer)
Marble	Glass
Platform	Wood
Bearing	-
Hammer	Iron (can be changed)

III. CONCLUSION AND DISCUSSION

The results obtained from the observations and calculations made are given in the table below.

Velocity of the Hammer After Impact	**1.75 m/s**
Velocity of the Marble After Impact	**3.16 m/s**
Flight Time in Projectile Motion	**0.255 s**
Displacement at x-axis	**0.81 m**
Initial Velocity of the Hammer	**2.05 m/s**

Since the project could not be carried out in a laboratory environment, air resistance is ignored. Therefore, since air resistance is not taken into account, the above operations are not strictly correct, they are the ones that are closest to the physical rules. Some sort of minor deviations may occur in real-life experiments.

These deviations will negatively affect our calculations. The deviation will be shown as the effect of the air resistance when the design is implemented.

When the formulas are observed, it is obviously seen that there is no mass effect in mechanical energy transformation of the hammer. For that reason, the velocity that the hammer has before the collision is only related to the height at which the center of weight is located.

Velocity cannot be transferred in the same way due to reasons such as different materials after collision. At this point, the velocities of the two bodies after the collision were calculated with the definition and formula of the coefficient of restitution.

When the projectile motion calculations are observed, it is possible to see the resulting velocity of the ball is always constant on the horizontal axis. Therefore, the path taken by the ball on the horizontal axis was calculated by multiplying the time found from the free fall formula and resulting velocity.

The design was carried out in accordance with the purpose in the first step of the project. In this way, it will be ensured that the glass ball enters the hollow cube with a projectile motion.