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Design and Analysis of a Model Rocket

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Design and analyze Model rocket with the payload of 10 Kilogram capable of reaching 30 km altitude.
Parameters of the ModelRocket

Total length of rocket - 525 cm
Total Mass of the rocket - 148.211 kg Max Apogee - 33.173 km
Max velocity - 883 m/s (Mach 2.86) Max acceleration – 102 m/s^2 Stability – 2.52 Cal
CG – 309 cm CP – 355 cm

ABSTRACT.

The model rocket was designed to reach the apogee of 30000m carrying apayload of 10kg. So, it was designed with 3 stages (2 booster stages and 1 sustainer stage). This model is designed such that, the total weight of the rocket is 148.211 kg and it is reaching an apogee of 33.173 km. 1^{st} stage consists of the nose cone, body tube and fins. 2^{nd} and 3^{rd} stage consists of just the body tube and the fins. To connect each of the body tubes the coupler has been installed.

While analyzing the flight simulation for our Model Rocket, the Altitude and Vertical velocity is plotted with respect to time and Different stages of flight are shown in the simulation graph. For example, Motor burnout, stage separation etc. here launch rod length was set to 1100 cm (double the length of the rocket)

I. INTRODUCTION TO OPEN ROCKET.

ThesoftwarewaswrittenentirelyinJavaformaximumportabilitybetweendifferentoperatingsystems.Asignificantamountof effortwasputintomakingthegraphicaluserinterface.ThesoftwarewasreleasedunderthecopyleftGNUGeneralPublicLicense (GPL) [36], allowing everybody access to the source code and permitting use and modification for any purposes. The only major restrictionplacedisthatifamodifiedversionisdistributed, thesourcecodeforthemodificationsmustalsobeavailable undertheGNU GPL.ThisensuresthattheprogramstaysfreeandOpenSource;acompanycannotsimplytakethecode,enhanceitandstartsellingit as their own without contributing anything back to the community. Open Rocket software package, which includes an easy-to-use user interface for designing and simulating model rockets. The software has been published as Open Source software. Open Source software, on the other hand, has become an increasingly competitive alternative to proprietary software. Open Source allows free access to the source code of the programs and encourages users with the know-how to enhance the software and share their changes. Success stories such as the Linux operating system, the OpenOffice.org office suite, the Firefox web browser and countless others have shown that Open-Source oftwarecanoftenachieveandevenexceedthequalityofexpensiveproprietarysoftware.Modelrocketsimulation isapowerfultoolallowingrocketeerstodesignandsimulatetheflightofrocketsbeforetheyareactuallybuilt.

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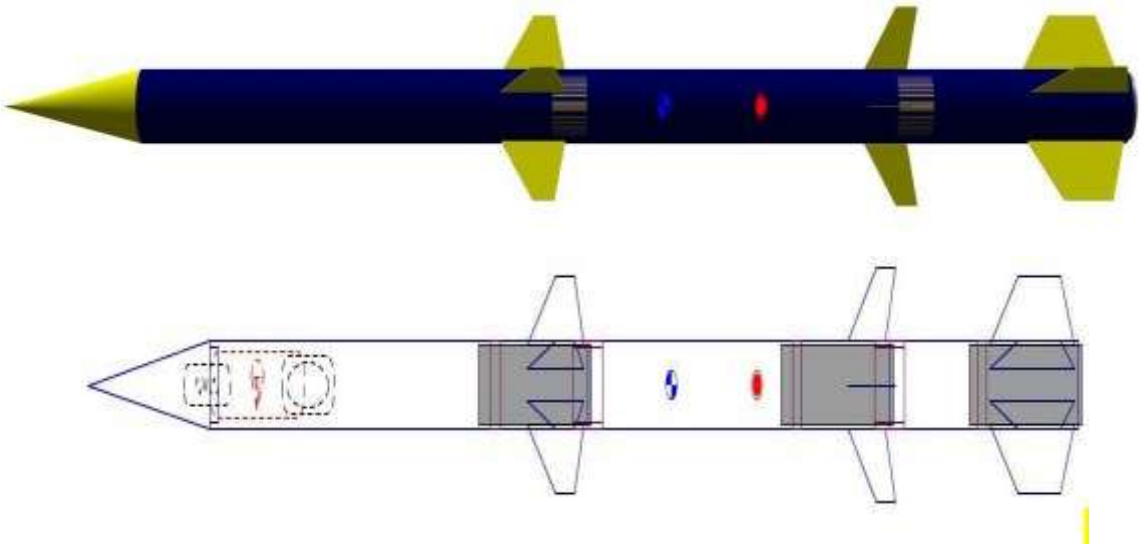
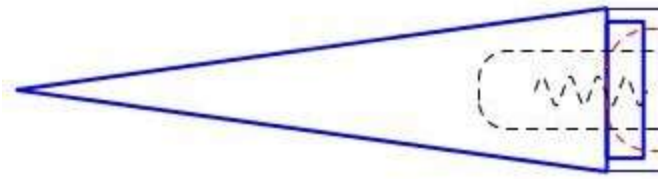
II. DESIGNING MODELROCKET.

Model Design- Images and Figures



COMPLETE BREAKDOWN OF MODEL ROCKET PARTS.
STAGE 1

- **NoseCone:**



The nose cone is of conical shape and made of brass. The length of the nose cone is 65 cm with base diameter of 18cm. The nose cone shoulder is of diameter 15 cm and length of 4 cm.

The conically shaped forwardmost section of a rocket, missile or aircraft, designed to modulate oncoming airflow behaviors and minimize aerodynamic drag is called Nose Cone.

They are also designed for submerged watercraft such as submarines, submersibles and torpedoes, and in high-speed land vehicles such as rocket cars and velomobiles. The aerodynamic shape of the nose cone helps to prevent air from slowing the rocket.

- **Body tube:**

The body tube is made of steel. The length of the body tube is 200 cm and the diameter (outer) is 18 cm.

Components inside this body tube are:

- PAYLOAD –10kg
- PARACHUTE- 400 cmdiameter
- SHOCK CORD-100 cmlength
- MOTOR- O8000-P (Cesarone) -Total impulse -41125N/m^2
- ENGINE BLOCK- 17.6 cm outerdiameter

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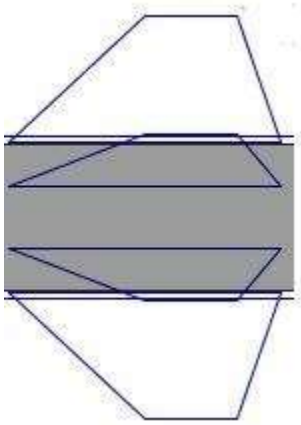
PAYLOAD: -The object or the entity which is being carried by an aircraft or launch vehicle or rocket is referred as payload. Sometimes it is also referring to the carrying capacity of an aircraft or launch vehicle or rocket, usually measured in terms of weight. The payload of a vehicle may include cargo, passengers, flight crew, munitions, scientific instruments or experiments, or other equipment it is because of the nature of the flight or mission.

PARACHUTE: -The parachute in a model rocket system that deploys at apogee and controls the fall of the rocket. The parachute is what slows the rocket to its final landing speed.

SHOCK CORD: - An elastic piece of fire-resistant material which connects the nose cone with the body tube of the model rocket. This cord is mainly use to keep the nose cone attached with the rocket when it is separated and after the recovery system of the rocket has been deployed.

BODY TUBE: - The main cylindrical body of the model rocket is referred as the body tube or airframe tubing. Body tubes for model rocket are general made from lightweight wound cardboard tubing to keep the weight of the rocket down. It is also made up from Blue tube, fiberglass, and clear polycarbonate tubes. As the weight of the rocket is very essential factor in order to gain its apogee.

➢ **Fins:**



The fins are trapezoidal fin set. 4 fins are used for better stability tilted at an angle of 22.5. The fins are made of Carbon Fiber.
FINS: - Fins in a model rocket gives stability and guide a rocket's flight trajectory by creating a center of pressure that is aft of its center of gravity.

It also gives optimize stability and drag to create the desired flight characteristics of the rocket. Without the stabilization of rocket the center of pressure would be too close to the front of the rocket in relation to the motor.

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STAGE 2:

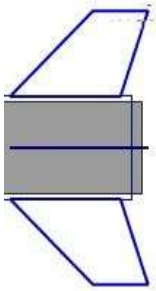
➢ **Body tube:**

The body tube is made of Fiber Glass. The length of the body tube is 160 cm and the diameter (outer) is 18 cm. Components inside this body tube are:

- TUBE COUPLER –17.6 outer diameter (Carbon Fiber)
- MOTOR- O8000-P (Cesarone) -Total impulse -41125N/m^2
- ENGINE BLOCK- 17.6 cm outerdiameter

TUBE COUPLER: - High powered rockets where durability is more important to the builder in order make sure tube coupler is used. It is made from a vulcanized paper to give it very good strength, but it is not brittle at all.

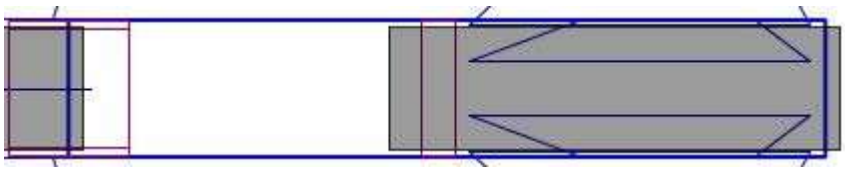
➢ **Fins**



The fins are trapezoidal fin set. 4 fins are used for better stability. The fins are made of Carbon Fiber.

STAGE 3:

➢ **Body tube:**



The body tube is made of Fiber Glass. The length of the body tube is 100 cm and the diameter (outer) is 18 cm. Components inside this body tube are:

- TUBE COUPLER –17.6 outer diameter (Carbon Fiber)
- MOTOR- O8000-P (Cesarone) -Total impulse -41125N/m^2
- ENGINE BLOCK- 17.6 cm outerdiameter

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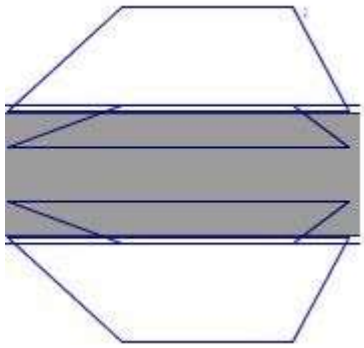
➢ **Fins:**



The fins are trapezoidal fin set. 4 fins are used for better stability tilted at an angle of 22.5. The fins are made of Carbon Fiber.

ENGINE BLOCK: - The engine block, or thrust ring, help in keeping the rocket motor from moving forward into the rocket body during the thrusting phase of the flight. Engine blocks are usually thick paper rings that are glued into the motor mount tube.

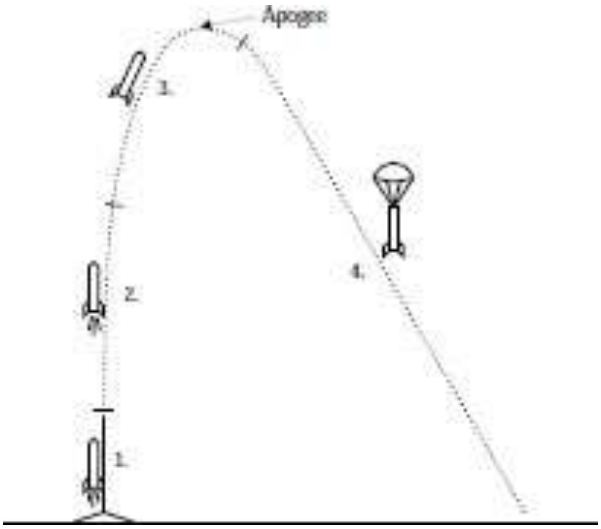
ENGINE: -

The engine of the model rocket is a commercially manufactured as solid-propellant engine. It is generally made from thick wound paper tubes and contains ceramic nozzle. Larger rockets use motor with plastic casing and ammonium perchlorate composite propellent and few engines uses metallic casing.

III. MODEL ROCKET FLIGHT.

A typical flight of a model rocket can be characterized by the four phases depicted in Figure below:

1. Launch: The model rocket is launched from a vertical launchguide.
2. Powered flight: The motor accelerates the rocket during the powered flightperiod.
3. Coasting flight: The rocket coasts freely until approximately at itsapogee.
4. Recovery: The recovery device opens and the rocket descends slowly to theground.



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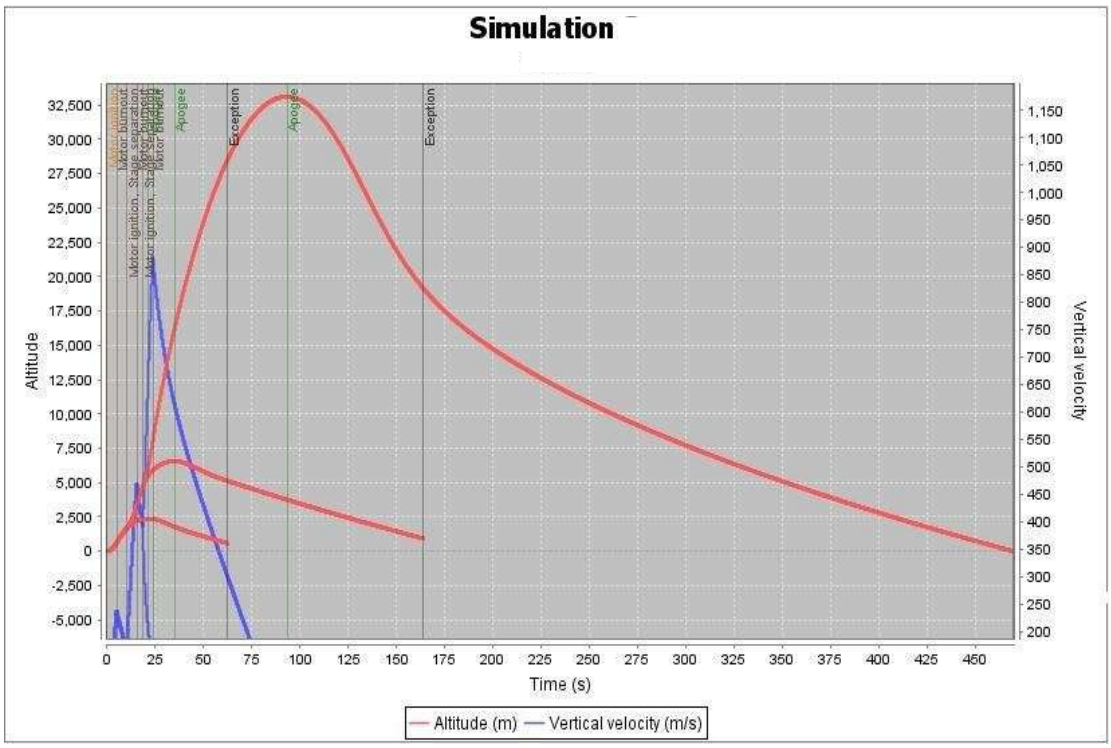
IV. RESULT.



	Name	Configuration	Velocity off rod	Apogee	Velocity at depl...	Optimum delay	Max. velocity	Max. acceleration	Time to apogee	Flight time	Ground hit velocity
1	Simulation 3	[38000-P; 08000-P; 0...	32.7 m/s	33116 m	N/A	69.4 s	884 m/s	103 m/s²	93.3 s	470 s	49.3 m/s

V. CONCLUSION

TheDesignandAnalysisoftheModelrocket wassuccessfullydoneanddisplayedtorelatewiththeab ove topic.
Herethe maximumapogeereachedwas33116mwithamaximu mgroundhitvelocityof49.3m/s.

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