TEAM UGANDA

Here is where your presentation begins

CONTENTS OF THIS PRESENTATION

QUESTION STATEMENT

All the spokes in a bicycle wheel are replaced byrubberbands. If the rubber bands on one side of the wheel are heated, the wheel starts to rotate. Investigate this effect.

INTRODUCTION

02

WHAT MAKES UP A RUBBER BAND?

RUBBER

- A rubber band is made up of atoms and its atoms are bonded together to form molecules and these molecules form the rubber band in its fully glory!
- At temperatures which are not absolute zero, these molecules are constantly vibrating around and bumping into one another.

THE RUBBER MOLECULE

- The molecules of rubber are very long chains(polymers) which are so long that they get tangled up in themselves resulting into the phenomenon of elasticity.(the rubber molecule is characterized by its giant length and freedom of movement)
- These long chains are made up of loosely joining monomers of isoprene for the case of natural rubber and 2-chloro-1,3-butadiene for the case of neoprene which is a synthetic rubber.
- Neoprene just happens to be used to make rubber bands.

STRETCHING A RUBBER BAND

- A rubber band has the ability to regain its original shape once a deforming force has been removed(said deforming force is also known as stretching) Elasticity plays a key role in the working of the upcoming experiment.

IN DEPTH

THE SCIENCE BEHIND
STRETCHING

THE SCIENCE

- Since rubber molecules are shaped like spaghetti, if you stretch a rubber band, you pull those spaghetti shaped molecules into a straight line, but the molecules are still in random motion(they are still moving around)
- They bump into each other and because of this motion, the molecules spread out sideways. They hence pull inward on the end of the rubber band in order to unstraighten (curl up or tangle)

THE CURL UP PROCESS

- The stretched rubber tries to become short, thick and flabby so that the molecules will have more room to move around sideways(the rubber band snaps back after being stretched)
- The elastic quality of a rubber band comes from its interconnected spaghetti shaped molecules and from the tiny, random jiggling motion of its molecules that cause it to resist straightening(oppose stretching)

THE SCIENCE BEHIND THE SCIENCE

THE UNIQUE CASE

- Thermal motion causes the ends of the molecules to draw together, hence stretched rubber bands contract on heating rather than expanding like most materials do.
- The disorder caused by thermal agitation of the rubber, makes its giant(long) molecules to draw together.
- Order can therefore be imposed on the long chain by pulling the ends of the rubber band and heat is given out.
- When the ends of the rubber bands are released, energy is absorbed.

VULCANIZED RUBBER

- It has chains which are crosslinked such that pulling on the ends of molecules does not lead to permanent deformation of the rubber because it does not cause the molecules to slide past each other.
- The number of cross links per unit area determines the elasticity of rubber as too many cross links result in a hard inelastic rubber and too little result in a soft and plastically deformed rubber.

CROSS LINK DENSITY

- the density of chains or segments that connect two infinite parts of the polymer network

PHENOMENON TO INVESTIGATE

The heat engine

HEATING THE RUBBER BANDS

- Each of the chemical bonds between two carbon atoms in the long polymer chain can rotate so that the chain is locally either straight or bent. There are many ways to rotate so that the chain bends but only one way to rotate so that the chain is straight and maximumly extended thus entropy favors shorter bent chains. There is also less disorder when the chains are straight. So the probability of the rubber band contracting on heating is much higher than its probability of expansion.

FURTHERMORE

- When we heat rubber band by increasing the temperature, we favour the free energy of structures having more entropy(at equilibrium, we favour shorter chains over longer chains and the rubber band contracts as a result, further solidifying our point

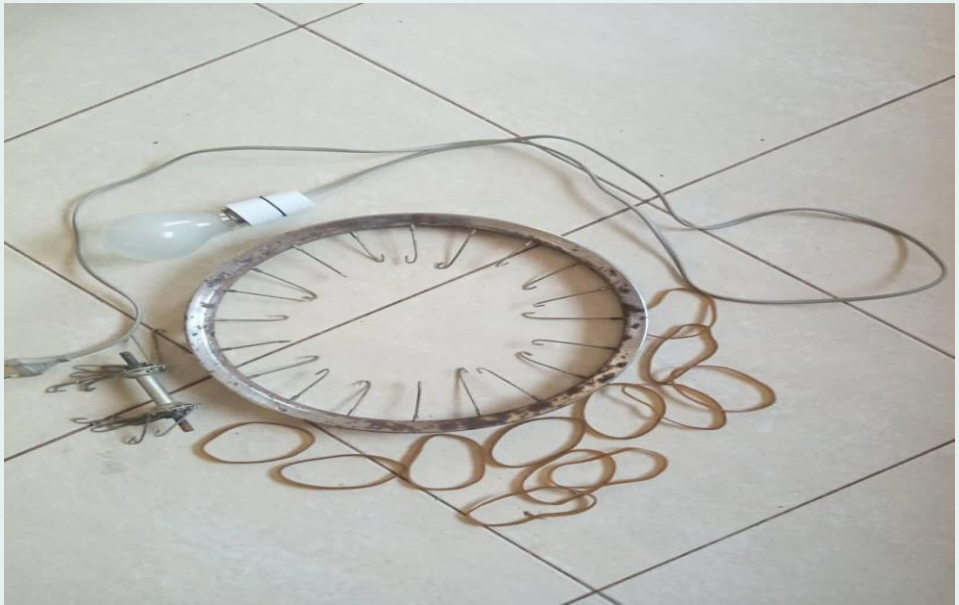
THE PHENOMENON NOW

- The setup of rubber bands, a bicycle wheel frame and a source are capable of converting heat energy to kinetic energy and the efficiency of such a set up.
- The rubber bands regain their shape after departing from the heat source.

THE EXPERIMENT

REQUIREMENTS

- Bicycle wheel
- Hub
- Thick rubber bands
- Wire cutters
- Blow drier



CAUTION

- Only thicker rubber bands should be used as the thin ones would snap on heating.
- A naked flame should not be used to heat the rubber as his would result into burning of the rubber and emission of poisonous gases.
- The hub of the wheel should be centrally located before applying the heat source

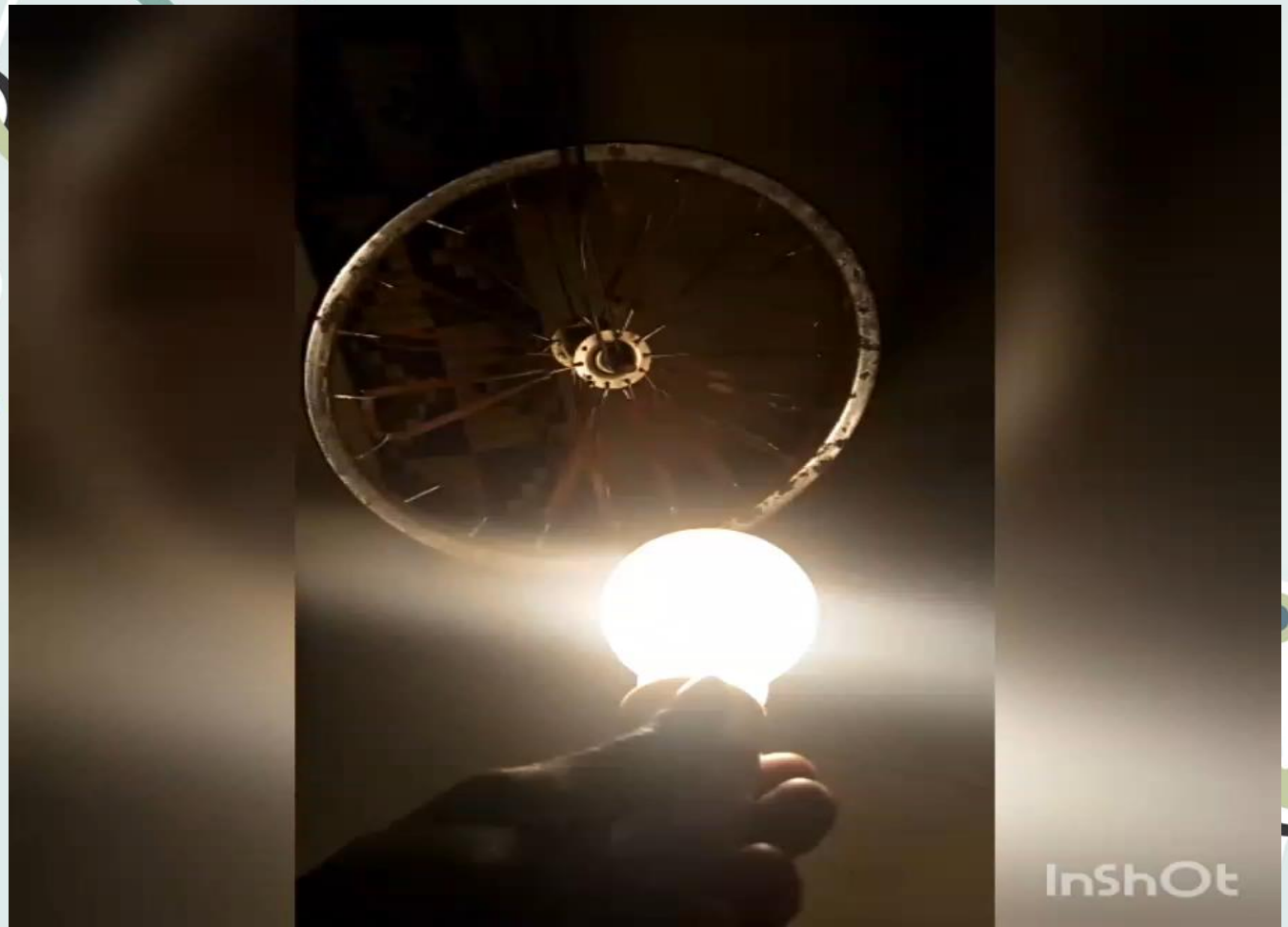
THE HUB

- This is the center of gravity of the wheel and carries the most of weight of any part of the wheel and will be very important for the theory of the experiment.

PROCEDURE

- The spokes of the bike wheel are removed such that the rubber bands can be attached
- The rubber bands are attached to the hub of the wheel such that it I s centrally located.
- The wheel is suspended such that it rotates about its axis freely.
- The blow drier is set to hot and turned on and applied to the rubber bands on the right side of the wheel.

The experiment video



OBSERVATIONS

- The wheel slowly rotated in the anticlockwise direction with uniform circular motion

THEORY BEHIND THE EXPERIMENT

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CIRCULAR MOTION

- When an object moves in such a way that its distance from a fixed point remains the same, it is said to have a circular motion and the rotation of our modified wheel definitely qualifies. For a normal wheel, the center of gravity would not change as the wheel rotates but in our new wheel, its circular motion majorly depended on the shifting center of gravity

DURING HEATING

- As the rubber bands on the right contract, they exert a pulling force on the hub, thereby changing the center of gravity of our wheel.
- The center axle shifts toward the outer rim causing the wheel to become unbalanced hence more weight is on one side causing the will to begin to spin.

THE UNHEATED RUBBERBANDS

- The cool rubber bands move toward the heat and the heated rubber bands move away from the heat and cool and regain their original shape due to their elastic property. This is the net force that produces the centripetal acceleration.
- This enables the wheel to move in a uniform circular motion.

CONCLUSION

EFFICIENCY

- We can conclude that this is not the most efficient way to create a heat engine because a lot of heat is utilized for a very miniscule output which can be calculated.
- This is because most of the heat from the blow drier does not reach the rubber bands.