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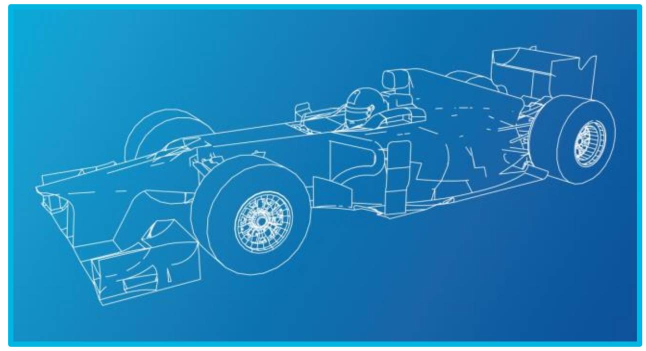
Lesson Focus

The focus of this lesson is on rubber band powered car design. Teams of students construct rubber band powered cars from everyday materials. Students must design their cars to travel in a straight line for a distance of at least 3 meters within a 1 meter wide track.



Lesson Synopsis

The "Rubber Band Racers" lesson explores the design of rubber band powered cars. Students work in teams of "engineers" to design and build their own rubber band cars out of everyday items. They test their rubber band cars, evaluate their results, and present to the class.

Age Levels

8-18

Objectives

During this lesson, students will:

- Design and construct a rubber band car
- Measure distance and calculate velocity
- Test and refine their designs
- Communicate their design process and results

Anticipated Learner Outcomes

As a result of this lesson, students will have:

- Designed and constructed a rubber band car
- Measured distance and calculated velocity
- Tested and refined their designs
- Communicated their design process and results

Lesson Activities

In "Rubber Band Racers" lesson students explore rubber band car design. Students work in teams of "engineers" to design and build their own rubber band car out of everyday items. They test their rubber band cars, evaluate their results, and present to the class.

Resources/Materials

- Teacher Resource Documents (attached)
- Student Worksheets (attached)
- Student Resource Sheets (attached)

Alignment to Curriculum Frameworks

See attached curriculum alignment sheet.

Internet Connections

- TryEngineering (www.tryengineering.org)
- International Federation of Automotive Engineering Societies: What do Automotive Engineers Do? (https://www.fisita.com/yfia/careers/what-does-an-automotive-engineer-do)

Recommended Reading

- The New Way Things Work (ISBN: 978-0395938478)
- Masters of Car Design (ISBN: 978-8854403376)

Optional Writing Activity

- Write a paragraph or essay explaining what automotive engineers must take into consideration when designing safe vehicles today.

For Teachers:
Teacher Resource

◆ Lesson Goal
Students design rubber band cars out of simple materials. They then test their cars to determine if they can travel in a straight line for a distance of at least 3 meters within a 1 meter wide track. The car that can travel within the track for the greatest distance is the winner.

◆ Lesson Objectives
During this lesson, students will:
- Design and construct a rubber band car
- Measure distance and calculate velocity
- Test and refine their designs
- Communicate their design process and results

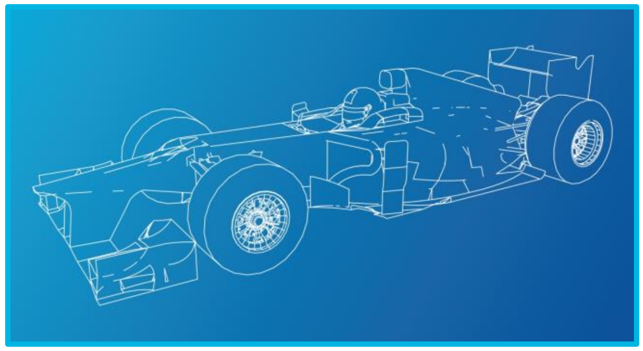
◆ Materials
One set of materials for each group of students:
- 16 in. x 16 in. piece of corrugated cardboard (or a cereal box/smaller piece of cardboard) and 4: CDs, paper plates, or plastic coffee, yogurt, or takeout lids)
- 4 rubber bands
- 3 unsharpened pencils
- 4 metal paperclips
- package thumb tack
- scissors
- masking tape
- meterstick
- stopwatch

◆ Procedure
1. Show students the various Student Reference Sheets. These may be read in class, or provided as reading material for the prior night's homework.
2. Divide students into groups of 3-4 students, providing a set of materials per group.
3. Explain that students must develop a car powered by rubber bands from everyday items, and that the rubber band car must be able to travel in a straight line for a distance of at least 3 meters within a 1 meter wide track. Rubber bands cannot be used to slingshot the cars. The car that can travel in a straight line for the greatest distance is the winner.
4. Students meet and develop a plan for their rubber band car. They agree on materials they will need, write/draw their plan, and present their plan to the class.
5. Student teams may trade unlimited materials with other teams to develop their ideal parts list.
6. Student groups next execute their plans. They may need to rethink their plan, request other materials, trade with other teams, or start over.
7. Next….teams will test their rubber band car. To ensure that the rubber band cars travel in a straight line, students can create a 1 meter wide “track” using masking tape on the floor.
8. Teams /complete an evaluation/reflection worksheet, and present to the class.

◆ Time Needed
- Two to three 45 minute class periods

Student Resource: Automobiles and Automotive Engineering

◆ Automotive Engineering



Automotive engineers design the vehicles that we use for life, work, and play. They are involved in aspects of engineering design ranging from the initial design concept all the way to production. They design, test and refine vehicles for safety, style, comfort, handling, practicality, and customer needs. The work of automotive engineers falls into three basic categories: design, development and production. The work of some engineers involves designing the basic part or systems of an automobile, such as brakes or engines. Research and development engineers devise solutions to various engineering challenges. Production engineers design the processes that will be used to manufacture the automobile.

Here are a few science concepts that will be helpful to keep in mind when designing and testing your rubber band car.

◆ Energy

Energy is the ability to do work. All forms of energy fall into two basic categories: potential energy and kinetic energy. Potential energy is mechanical energy which is due to a body's position. It is also known as stored energy. A car at rest has potential energy. Kinetic energy is mechanical energy that is due to a body's motion. For a car to move, potential energy must be transformed into kinetic energy.

◆ Newton's Laws of Motion

Sir Isaac Newton (1642 – 1727) was a brilliant mathematician, astronomer and physicist who is considered to be one of the most influential figures in human history. Newton studied a wide variety of phenomena during his lifetime, one of which included the motion of objects and systems. Based on his observations he formulated Three Laws of Motion which were presented in his masterwork Philosophiæ Naturalis Principia Mathematica in 1686.

Newton's First Law – An object at rest will remain at rest and an object in motion will remain in motion at a constant speed unless acted on by an unbalanced force (such as friction or gravity). This is also known as the law of inertia.
Newton's Second Law – An object's acceleration is directly proportional to the net force acting on it and inversely proportional to its mass. The direction of the acceleration is in the direction of the applied net force. Newton's Second Law can be expressed as: $F = ma$
Newton's Third Law – For every action there is an equal and opposite reaction.

Student Worksheet:
Design a Rubber Band Racer

You are a team of engineers who have been given the challenge to design your own rubber band car out of everyday items. The rubber band car needs to be able to travel in a straight line within a track for a distance of at least 3 meters within a 1 meter wide track. The car that can travel in a straight line within a track for the farthest distance is the winner.

◆ Planning Stage
Meet as a team and discuss the problem you need to solve. Then develop and agree on a design for your rubber band car. You'll need to determine what materials you want to use.

Draw your design in the box below, and be sure to indicate the description and number of parts you plan to use. Present your design to the class.

You may choose to revise your teams' plan after you receive feedback from class.

Design:

Materials Needed:

Student Worksheet (continued):

◆ Construction Phase
Build your rubber band car. During construction you may decide you need additional materials or that your design needs to change. This is ok – just make a new sketch and revise your materials list.

◆ Testing Phase
Each team will test their rubber band car. Your rubber band car must travel in a straight line for 3 meters within a 1 meter wide track. Calculate your car's velocity (distance traveled per unit of time). Be sure to watch the tests of the other teams and observe how their different designs worked.

Rubber Band Car Data			
	Distance Traveled within Track (m)	**Time Traveled within Track (s)**	**Velocity (m/s)**
Test 1			
Test 2			
Test 3			
Average			

Student Worksheet (continued):

◆ Evaluation Phase
Evaluate your teams' results, complete the evaluation worksheet, and present your findings to the class.

Use this worksheet to evaluate your team's results in the Rubber Band Racer Lesson:

1. Did you succeed in creating a rubber band car that traveled in a straight line for 3 meters within the track? If so, how far did it travel? If not, why did it fail?

2. Did you negotiate any material trades with other teams? How did that process work for you?

3. What is the average speed your car achieved?

4. Did you decide to revise your original design or request additional materials while in the construction phase? Why?

5. If you could have had access to materials that were different than those provided, what would your team have requested? Why?

6. Do you think that engineers have to adapt their original plans during the construction of systems or products? Why might they?

7. If you had to do it all over again, how would your planned design change? Why?

8. What designs or methods did you see other teams try that you thought worked well?

9. Do you think you would have been able to complete this project easier if you were working alone? Explain…

For Teachers:
Alignment to Curriculum Frameworks

Note: Lesson plans in this series are aligned to one or more of the following sets of standards:
- U.S. Science Education Standards (http://www.nap.edu/catalog.php?record_id=4962)
- U.S. Next Generation Science Standards (http://www.nextgenscience.org/)
- International Technology Education Association's Standards for Technological Literacy (http://www.iteea.org/TAA/PDFs/xstnd.pdf)
- U.S. National Council of Teachers of Mathematics' Principles and Standards for School Mathematics (http://www.nctm.org/standards/content.aspx?id=16909)
- U.S. Common Core State Standards for Mathematics (http://www.corestandards.org/Math)
- Computer Science Teachers Association K-12 Computer Science Standards (http://csta.acm.org/Curriculum/sub/K12Standards.html)

◆National Science Education Standards Grades K-4 (ages 4 - 9)

CONTENT STANDARD A: Science as Inquiry

As a result of activities, all students should develop
- Abilities necessary to do scientific inquiry

CONTENT STANDARD B: Physical Science

As a result of the activities, all students should develop an understanding of
- Properties of objects and materials

CONTENT STANDARD G: History and Nature of Science

As a result of activities, all students should develop understanding of
- Science as a human endeavor

◆National Science Education Standards Grades 5-8 (ages 10 - 14)

CONTENT STANDARD A: Science as Inquiry

As a result of activities, all students should develop
- Abilities necessary to do scientific inquiry

CONTENT STANDARD B: Physical Science

As a result of their activities, all students should develop an understanding of
- Motions and forces
- Transfer of energy

CONTENT STANDARD F: Science in Personal and Social Perspectives

As a result of activities, all students should develop understanding of
- Risks and benefits
- Science and technology in society

CONTENT STANDARD G: History and Nature of Science

As a result of activities, all students should develop understanding of
- History of science

For Teachers:
Alignment to Curriculum Frameworks

◆National Science Education Standards Grades 9-12 (ages 14-18)

CONTENT STANDARD A: Science as Inquiry

As a result of activities, all students should develop

- Abilities necessary to do scientific inquiry

CONTENT STANDARD B: Physical Science

As a result of their activities, all students should develop understanding of

- Motions and forces

CONTENT STANDARD F: Science in Personal and Social Perspectives

As a result of activities, all students should develop understanding of

- Science and technology in local, national, and global challenges

CONTENT STANDARD G: History and Nature of Science

As a result of activities, all students should develop understanding of

- Historical perspectives

◆Principles and Standards for School Mathematics (ages 11 - 14)

Measurement Standard

-Apply appropriate techniques, tools, and formulas to determine measurements.

- solve simple problems involving rates and derived measurements for such attributes as velocity and density.

◆Principles and Standards for School Mathematics (ages 14 - 18)

Measurement Standard

- Apply appropriate techniques, tools, and formulas to determine measurements.

- analyze precision, accuracy, and approximate error in measurement situations.

◆Standards for Technological Literacy - All Ages

Technology and Society

- Standard 5: Students will develop an understanding of the effects of technology on the environment.
- Standard 7: Students will develop an understanding of the influence of technology on history.

Design

- Standard 8: Students will develop an understanding of the attributes of design.
- Standard 9: Students will develop an understanding of engineering design.
- Standard 10: Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.

The Designed World

- Standard 18: Students will develop an understanding of and be able to select and use transportation technologies.