PaperBot Series

Rubber Band Car Activity

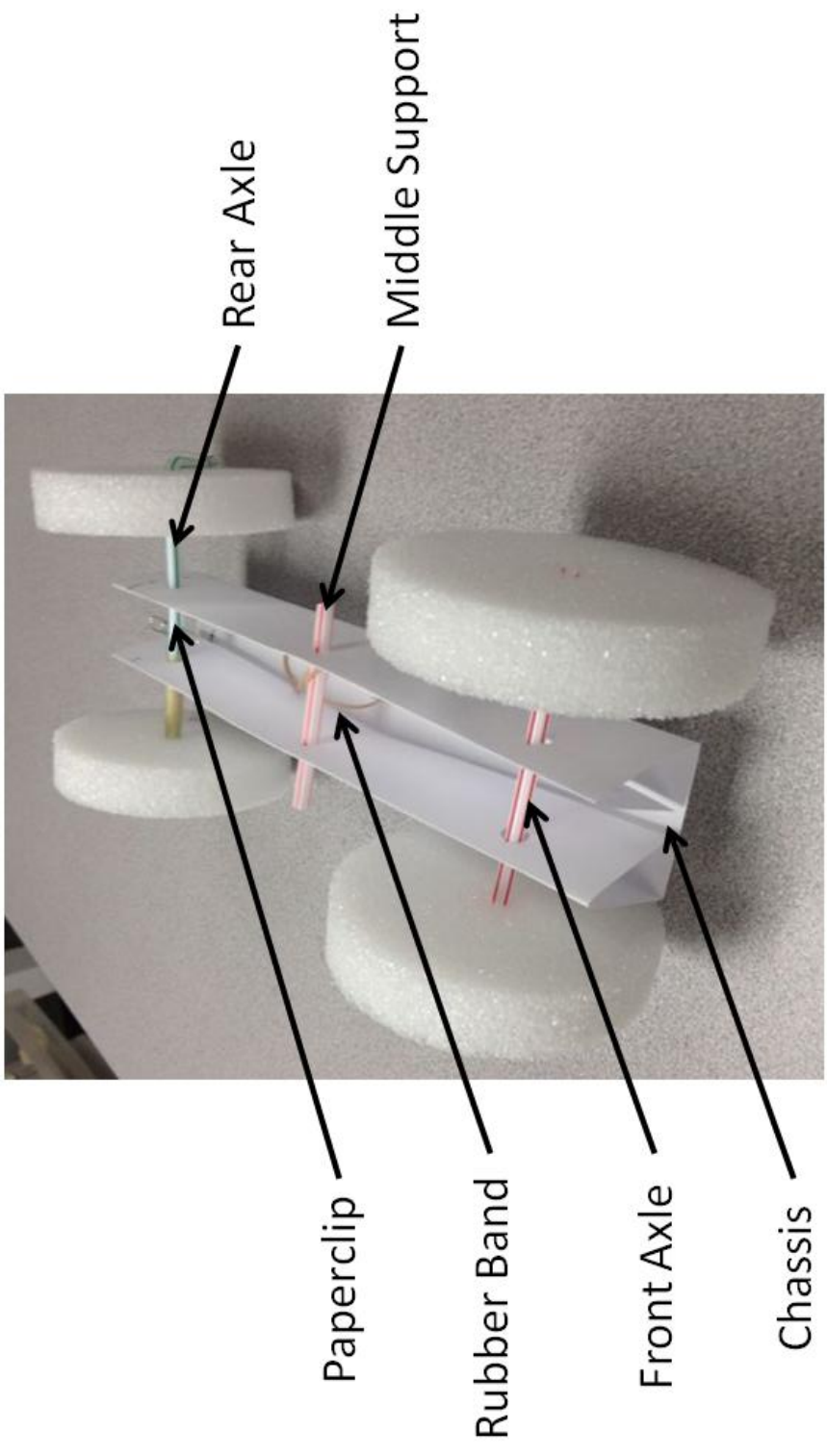
Subject: Science & Technology
Grade Level: 3 - 5
Topic: Design iterations to maximize efficient energy transfer.
Activity Time: 45 minutes

Goals	Students will be able to: 1. Understand that energy transfers from the band into car motion 2. Iterate design to maximize car performance by gaining an understanding of structure, component interaction, and energy loss.
Objectives	To create a rubber band car that can travel a distance of 5 feet or greater.
Materials	Paper, Straws, rubber bands, 4 Styrofoam disks (per car), paper clips, masking tape, zip ties (optional), toothpicks (optional), measuring tape, single hole punch, scissors
Introduction	Introduction topics: 1. Energy transfer from the rubber band motor into the motion of the car 2. Car components (chassis, structure, wheels, axles, band/motor) 3. Freeform design and iterations, possible modifications may include: a. Wheel size (if applicable) b. Chassis form c. Band winds d. Structure e. Weight distribution Teacher should encourage design iteration to aid in students' understanding of key design concepts.
Procedure	1. Introduce activity and show students pictures of toy cars 2. Split students into teams of two or three 3. Distribute required materials and assembly instruction sheet provided. 4. The assembly instructions are a guideline for students to use while constructing their car. Allow and encourage different build procedures, use of different structures and mechanisms, as well as different materials and design features. Encourage creativity while still emphasizing that the car should travel using the rubber band motor. 5. When students have completed their initial car assembly, have them set up their car at the starting line with their two front wheels lined up at the edge of the line. The student should measure the total distance traveled and document the measurement in their notes. (Note: It is suggested that the class watch the initial car demonstrations to learn from others ideas). 6. Students should perform test two more times and document the measurements. 7. Students should attempt to iterate their design two more times with three distance trials per design. Students should document their results and make note of what design modifications worked best and why. 8. After all students have finished their tests the class should reconvene and present their findings to one another.
Wrap-up	Suggested discussion points: 1. Were any existing designs used as inspiration? 2. What design changes increased car performance? 3. Why do those design changes increase performance? 4. What are other forms of energy transfer that you commonly use?

Educational Standards:

Massachusetts State Standards for Educational Framework – Science – Grade 5

- MA.SIS.1 → Ask questions and make predictions that can be tested.
- MA.SIS.3 → Keep accurate records while conducting simple investigations or experiments.
- MS.SIS.4 → Conduct multiple trials to test a prediction. Compare the results of an investigation or experiment with the prediction.
- MA.SIS.5 → Recognize simple patterns in data and use data to create a reasonable explanation for the results of an investigation or experiment.
- MA.SIS.6 → Record data and communicate findings to others using graphs, charts, maps, models, and oral and written reports.
- MA.PS.4 → Identify the basic forms of energy (light, sound, heat, electrical, and magnetic). Recognize that energy is the ability to cause motion or create change.
- MA. PS.5 → Give examples of how energy can be transferred from one form to another.
- MA.T/E.2.3 → Identify relevant design features (e.g. size, shape, weight) for building a prototype of a solution to a given problem

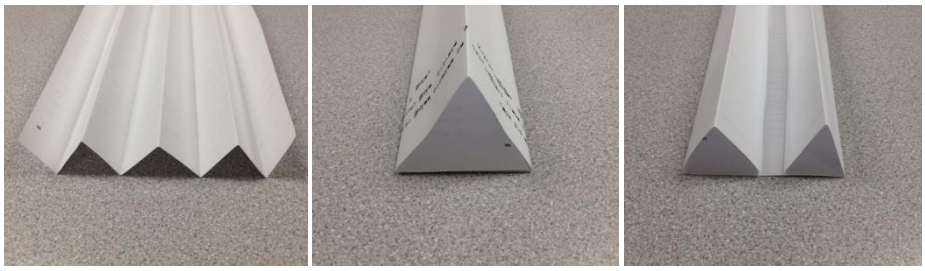

Rear Axle
Middle Support
Paperclip
Rubber Band
Front Axle
Chassis

Assembly Instructions

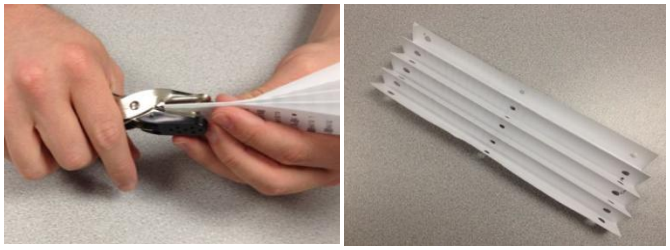
1. Split into a team of two or three.

2. Gather materials: 3 sheets of paper, 4 straws, 3 paper clips, 2 rubber bands, 4 foam wheels, tape, single hole punch, and scissors

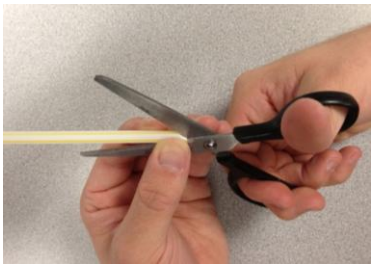
3. Make a paper chassis



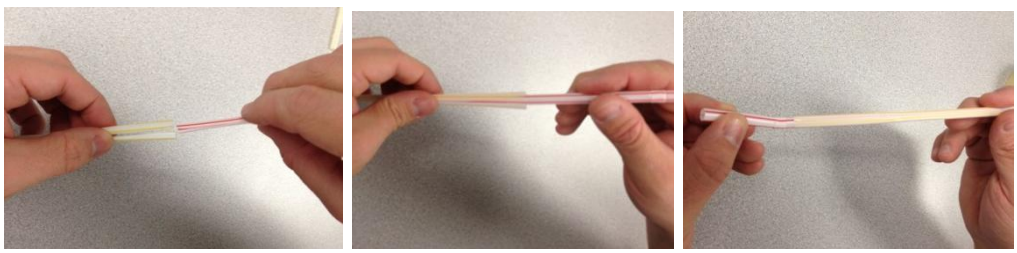
4. Create holes with a hole punch for the front and back wheel axles as well as the middle support. (Note: standard hole punch might not make a hole large enough for the straw, multiple punches may be needed)



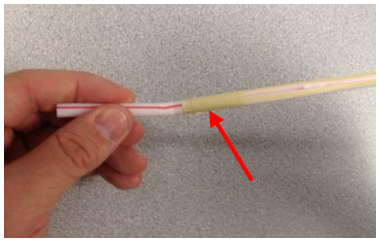
5. Take two straws and cut long section of straw lengthwise to about half the length



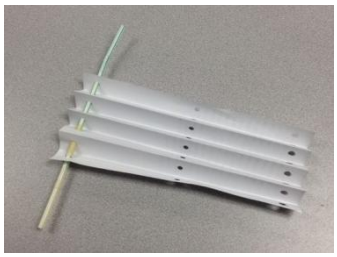
6. Insert split end of one straw into the split end of the second straw.



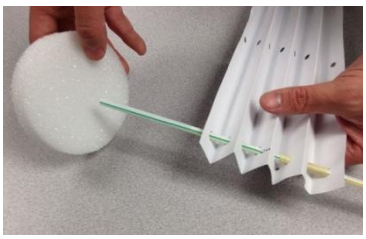
7. Tape ends of the straws together to make sure they do not move.

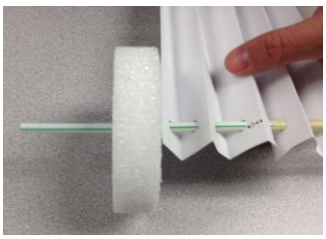


8. Insert two-straw axle into rear axle holes of chassis.

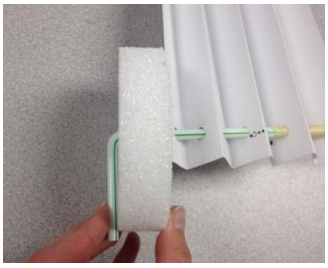


9. Insert a foam wheel onto either end of the two-straw axle by pushing the straw through the center of the foam wheels. The wheel should be pushed past the bending portion of the straws.



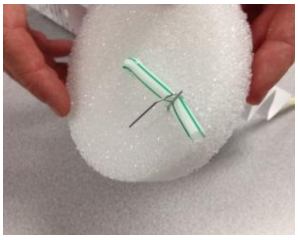


10. Bend each straw so that the side of the straw is pressed against the outside wheel wall.

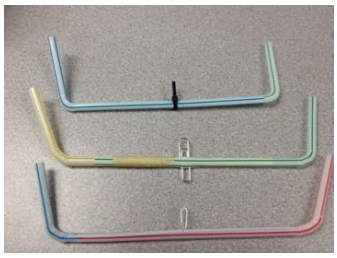


11. Secure the straws to the foam wheels using a paper clip that has been straightened on two sides to make a 'U' shape.





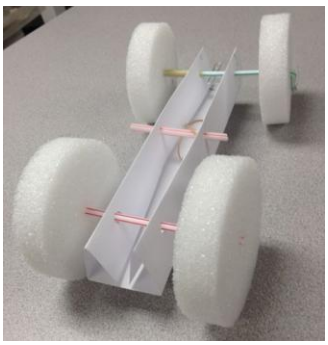
12. Use a zip tie or paperclip in the center of the rear axle. The zip tie or paperclip should extend approximately ½" above the surface of the straw.



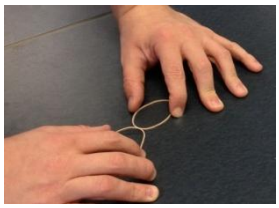
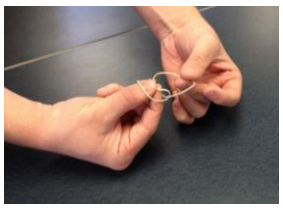
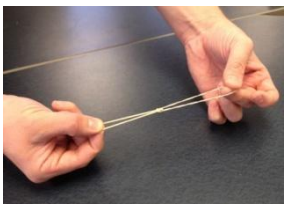
13. Cut the front axle straw to a length you think is best. Insert front axle straw through the holes in the chassis.

14. Insert wheels onto either end of the front axle. Do not push the foam wheel past the entrance of the straw.

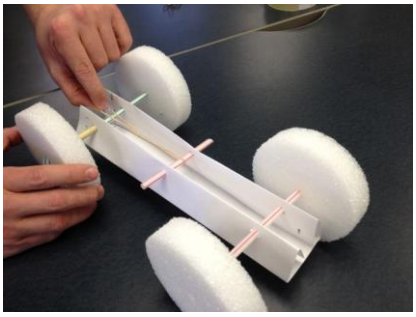
15. Use a straw to provide support in the middle of the chassis by inserting it through the previously punched holes.



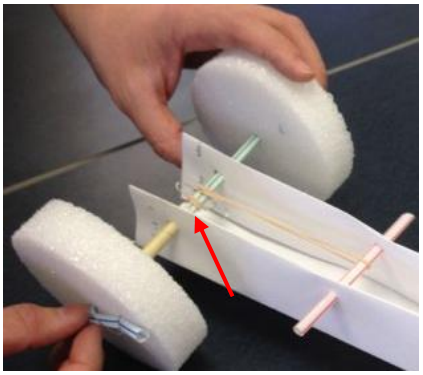
16. Secure two rubber bands to one another and then around the middle support.

17. Attach the rubber band to the zip tie or paperclip on the rear axle.



18. Wind rubber band around the rear axle by turning the wheels.



19. Place on ground and release car from the starting line.

20. Measure the total distance traveled from the starting line.

21. Run test two more times and note the distance traveled for each test.

22. Iterate design to improve distance traveled.

Iteration	Design Changes	Trial	Distance (in)	Observations
1	Initial Design	1		
		2		
		3		
2		1		
		2		
		3		
3		1		
		2		
		3		