“Pasta”- bilities: Noodling Your Way into Simple Machines

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Teacher Section

Purpose	The purpose of this lab activity is to build upon student knowledge of and interest in simple machines. Students will develop their own lab design, which incorporates the building and racing of a gravity-fed, pasta racecar of their own design. The initial section of the lab includes brainstorming/questioning; observations; and student developed experimental design. The second section of the inquiry leads students to collect data (speed, acceleration, and deceleration force) and design a data table. Students will also re-design their pasta cars for maximum speed.
Objectives	**The student will be able to:** Use the scientific method to hypothesize, collect data, graph and draw conclusions. Identify each simple machine in the pasta car design. Understand the following terms: effort, resistance, mechanical advantage, force, acceleration and friction. Work cooperatively in a group. Communicate ideas and observations during the car design process. Build a car that moves by gravity. Use a calculator to calculate the following formulas: speed, force and acceleration. Record data on data collection sheets and interpret data to draw a graph. Use a meter stick or ruler to measure linear distances. Weigh objects on a scale. Handle materials in a safe and appropriate manner.
Grade Level	Middle to High School
National Science Education Standards Alignment	**Science as Inquiry**—These are abilities necessary to do scientific inquiry within a framework of accepted *national objectives*. **Physical Science**—Specifically, there are demonstrations of energy transfer in the context of a compound machine and laws of motion.
Time Required	This lab, including pre-lab suggested activities, can be accomplished within one week. If you choose to give students as much independence as possible, you may find that they will ask for more help. Resist the impulse to offer too much help (depending on the age group), or you will find the lab could run two weeks.

Teacher Section

Prior Knowledge

This unit supports what students have already read or learned about simple machines. It gives them the opportunity to try out a design that uses as many simple machines (wedge, screw, pulley, wheel and axle, inclined plane and lever) as possible. Included are some simple explanations to aid in student discussion.

Wheel and axle: a wheel is locked to a central axle so that when one is turned the other must turn. This is important for moving the car.
Pulley: a pulley trades a longer distance for a lesser force.
Inclined plane: This is an angled design that allows a longer distance to make it easier to move upward.
Wedge: a wedge converts motion in one direction into a splitting motion that acts at right angles to the blade. Think of a wedge as two inclined planes, back to back.
Screw: The design is simply a spiraled incline plane.
Lever: This is a rod that moves over a fixed pivot point.

Safety

Before and during the procedures, practice lab safety. Concern must be continually re-emphasized to ensure the safety of all students.
Stress adequate distance in the use and handling of the hot glue guns. Each glue gun needs time to cool.
Keep ice nearby if burns occur from touching either the glue or glue gun.
Do not allow students to eat the pasta. Some students may have allergies of which you are not aware.
Be watchful for students who may want to play with the equipment.

Questions to Ask Along the Way

1. What can you do to change the speed of your car?
Build the car with a more rounded shape, increase the weight or bring the wheels closer to the car body.

2. Why are cars important to society?
They are important for transportation, traveling long distances and commerce.

3. What is gravity?
Gravity is a force that causes objects to stay put, move downhill or drop from different heights.

4. What is friction?
Friction is a force that slows a moving object.

5. What is mechanical advantage (MA)?
Mechanical advantage is the ability of a machine to make work easier, by trading distance for less effort.

6. What are some characteristics of simple machines?
See background information.

Pre-Lab Activity

Depending on the age group and ability, you can begin the lab by:

Using a **KWL** approach about cars in general. That is:
- **K** = what they know about cars
- **W** = what they want to know about cars
- **L** = what they have learned about cars after the lab

Using a computers hooked up to the Internet, do a web search. Students can use questions generated from KWL or individual questions using web sites you provide to answer their questions. See the "Useful Web Sites" section for possible web sites.

Preparation

IT IS STRONGLY SUGGESTED THESE CONSIDERATIONS BE READ BEFORE ATTEMPTING THIS LAB.

- Inquiry-based labs require a lot of student independence. Weigh your decision to complete this lab after considering the abilities of your students.
- Offer students both glue and glue gun. They will soon realize which glue holds well.
- The lasagna makes the best base for the cars.
- The wheel and axle can be made using the rotelle (wagon wheels) and spaghetti. The small diameter circles will hold the spaghetti to the rotelle more securely.
- A movable door can be made by placing part of a lasagna noodle in hot water, then shaping it over a curved surface. Glue the door to a hollow noodle. Attach a piece of spaghetti noodle and slide the hollow noodle over it. Other desired shapes can be made by first boiling different noodles.
- A movable ball and hitch can be made by making a trailer, gluing it to a circular noodle, and placing the circular noodle (0) over a fixed piece of spaghetti noodle.
- Students need to glue one rotelle to the spaghetti, and then glue the ziti underneath the body of the car, so that both wheels will turn.
- Caution: Keep a careful watch on the use of the hot glue guns.
- Consider gender issues and abilities. Allow students to make car designs as simple or as complex as they desire. Cooperative pairing will help overcome some of the barriers.

Materials

Have enough materials, especially adequate pasta, glue and glue sticks.

- Meter sticks/ rulers
- Scissors
- Glue
- Mini-glue gun + glue sticks
- Aluminum pie pans
- Newspaper
- Masking tape
- Paints, paint brushes
- Margarine cups
- Water bottle
- Heavy acrylic board (1-m wide and 1½-m long)
- Markers, crayons
- Poster board
- Assorted pasta: lasagna, rotelle, penne, spiral, spaghetti (thick & thin), small diameter circles, ziti, wagon wheels

Procedure

Procedure 1:
Depending on the age group, inquiry-based activities help foster independence and higher order thinking skills, by allowing students to design and run a lab with minimal assistance. Using the inquiry-based approach, students can design the experiment, which includes building and running a gravity-fed pasta car. Once the teacher approves student-designed labs, students will discuss their designs, draw them on paper and write design notes. Students will use communication and writing skills. It is important to note that car modification will evolve over time and experimentation. For example, if the wheels are too far from the base of the car, the axles may break or the car will move slower.

Procedure 2:
Assemble the "race track" by placing the acrylic board at about a 45-degree angle on a chair. If you do not have an acrylic board, then use plywood. You can add all kinds of variables, such as changing the height and board length. Once the cars are built, allow students complete access to the track for practice runs. Students will be able to visually and tactually note design errors. Have students tape down the board. They can also practice measuring the one-meter length the car must run beyond the board, and measure their actual race distances. NOTE: The car must travel down the track on its own gravity power and roll on its own wheels, a minimum length past the end of the track.

Another good way to practice measuring is to have students weigh their cars and determine car length. Older students in physical science or physics will need the weights to determine the following formulas:

Speed = distance (meters)/time(sec)
Acceleration = change in speed/time, or T2 – T1/time
Force = mass (grams) x acceleration

Data Table Example

Trial	Speed	Acceleration	Force
1			
2			
3			

The real fun is observing students race each other. Keep a watchful eye for students that are so keyed into winning that they take "measures" to assure a victory. Some prizes for winners (fastest, best design) may include canned pasta. You may also consider giving each runner up a box of mac and cheese.

Procedure 3:
The final understanding of the student-produced lab can be in the form of a poster presentation or formal assessment. If you want you can write a rubric (see Poster and Presentation Rubrics at the end of this lesson) that includes the data table, graph, drawings, etc.

Suggestions for Assessment

Several possible assessment rubrics for evaluation of students are included at the end of this lesson. The teacher is encouraged to use more than one way to assess students. The most useful way to assess is through teacher observation or student/peer evaluation. Unless you present specific rubrics or pre-defined expectations, students will not have an adequate way of measuring success.

Extensions

Find out how pasta is made.
Research different fuels used to run cars.
Visit the school's shop, examine a real car and have students identify the simple machines incorporated within a working model.
Bring a car engineer to class to discuss car design.
Explore whimsical machine designs by Rube Goldberg.
Have students bring in a broken appliance. Disassemble with simple tools and try to fix it.
Compare the machines of the present with machines of the past.
Email a scientist.

References & Resources

1. Malone, Mark R. (Ed.) Physical Science Activities for Elementary and Middle School. Clearing House for Science, Mathematics and Environmental Education. Ohio State University. December 1987. pp. 205-207.
2. American Association for the Advancement of Science. (1993). Benchmarks for Science Literacy. Oxford: Oxford University Press.
3. Kardos, Thomas. Physical Science Labs Kit: Ready-to-Use Activities and Worksheets for Grades 5-9. West Nyack, NY. The Center for Applied Research in Education. 1993.
4. Mcaulay, David. The Way Things Work. Boston: Houghton Mifflin Co. 1998.
5. VanCleve, Janice. Janice VanCleve's Physics for Every Kid: 101 Easy Experiments in Motion, Heat, Light, Machines and Sound. NY: John Wiley and Sons, Inc. 1991.

Useful Web Sites

1. www.teach-nology.com/teachers/lesson-plans/science
This "web portal for educators." Has links to science worksheets/labs and lesson plans.

2. www.the-aps.org/education/k12curric/index.htm
Featured are teacher-developed lab activities that integrate inquiry as a basis for experimentation.

3. www.fi.edu/qa97
Great resource for simple machines. Includes curriculum units for study and projects.

4. http://ousd.k12.ca.us/~codypren/machines.html
Cody's Science Education Zone offers lessons on simple machines, Grades 6-12.

6. http://www.mos.org/sln/Leonardo/InventorsToolbox.html
Learn about devices that make work easier to do by providing tradeoff between force and the distance over which force is applied.

7. http://www.san-marino.k12.ca.us/~summer1/machines/simplemachines/html
This website contains pictures of simple machines.

8. www.mos.org/sln/Leonardo/sketchGadgetAnatomy.html
Check it out! Close observation and sketching lead to a better understanding of simple machines.

9. www.howstuffworks.com
Great site for upper elementary through high school students to learn about how things work in the world.

10. www.iit.edu/~smile/index.html
The ultimate site! Collect hands-on lessons related to physics. Find multi-grade lesson plans organized by topic and subtopic.

11. www.educsapes.com/42explore/simplmac.htm
Website allows you to explore the basics of simple machines and gives researchers the opportunity to try different links.

Poster and Presentation
Grading Rubric

NAME: ______________________________

Title of Lab Activity: ______________________________

____

Topic	Criteria	Max Points	Points Earned
Problem	Clearly stated	10	
Research	Addresses problem	10	
Hypothesis	Supports research	10	
Experimental Design	Procedure, Materials, Control, Variables,	10	
Data Collection	Graph, chart show math Notes on design	10	
Data Displayed	Labels appropriate	10	
Conclusions	Data supports	10	
Communication	Poster display neat	10	
Presentation	Planned & organized; Group involvement	10	
Behavior	Attentive	10	

Total Points **100**

Car Design Rubric

Topic	Criteria	Max Points	Points
1. Simple Machines	minimum 3 used	10	
2. Weight	maximum 110-g	20	
3. Length	maximum 60 cm (does not exceed)	20	
4. Moves 1	must roll	10	
5. Remains intact	doesn't break	15	
6. Moves 2	moves down track	10	
7. Moves 3	travels 1 meter beyond track	15	

Bonus Points

1. Best Design	5
2. Longest Distance	5
3. Fastest Car	5
4. Multiple Use	5

Self-Evaluation Rubric

Title of Lab Activity: ____

1. Does my car solve a problem? Yes ____ No _____
2. Does my car use two or more simple machines? Yes ____ No _____
3. Have I designed my car and drawn a labeled picture? Yes ____ No _____
4. Did I have the supplies I needed to build my car? Yes ____ No ____
5. Did I actually build my car? Yes ____ No _____
6. Did my car move down the track to the minimum distance?
   Yes ____ No _____
7. Did I cooperate with my group in the car design and building?
   Yes ____ No _____
8. If I presented a poster, was the poster clear in its explanation?
   Yes ____ No _____
9. Did I follow all the safety rules? Yes ____ No _____
10. Did I clean up after I built the car? Yes ____ No _____

Key:
Each “Yes” is worth 10 points.
Each “No” is worth 5 points.

By doing this rubric scoring in this way, a student can score a C (75) average grade.