TLC junkyard wars™

COOL CARS

Teacher's Guide Notes

Junkyard Wars

This popular television show is anything but trashy entertainment. Each episode takes place in a huge, specially constructed junkyard, where two teams of engineers and mechanics get 10 hours to build machines scrounged from junk. Later the teams put their contraptions to the test in a competition. Viewers watch as the teams work to meet the same challenge in different ways.

First comes a challenge: Build an object to perform a specific task. Then the teams swing into action, struggling to beat the clock. They revise their plans as necessary. Throughout the show, an expert gives opinions and evaluations of projects. The hosts make diagrams to describe engineering principles behind each team's efforts.

Using the Videos

Each of the enclosed two videos (about 45 minutes each) features an episode of *Junkyard Wars.* On the following page are onscreen discussion questions for students to discuss and answer. These and additional questions for students are on the reproducible pages at the end of this teacher's guide.

In a 45-minute class period, you will not have enough time to show an entire episode and have students work on their reproducibles. You may show the first segments and allow students to make make hypotheses, answer questions, and evaluate some program events. Show the final segment, featuring the outcome of the program challenge, during the next class period.

In 60-minute class periods, you can show an entire episode and take sufficient time for students to complete their reproducibles. In 90- to 120-minute blocks, you can also conduct one of the four Classroom Challenges (laboratory experiments, projects, and demonstrations) included herein.

You may start some Classroom Challenges before or after you show the videos in class. You will want to assign the more substantial challenges after watching the videos.

It is helpful to keep some classroom lights on while watching a video so students can answer the onscreen discussion questions and make drawings on the reproducible pages. Pause the video when these questions appear.

Episodes in This Kit

Episode I: Hot Rods

Episode challenge: Build a dragster car.
Program Overview: To compete in a race, one team builds a hot rod with a heavy engine while the other builds a car based on a rail with a light body and less powerful engine.

Episode II: Off-road Vehicles
Episode challenge: Build a racing buggy
Program Overview: To build a vehicle that can complete an off-road rally course, one team customizes an old VW beetle and the other builds a light sand rail.

Target Grades: 6–12
Curriculum Focus: physics, physical science, technology, drafting and design, mathematics
Scientific Principles: Newton's Laws, speed and acceleration, energy and power, force and motion, construction

Onscreen Discussion Questions

(Note: Pause the video so students can answer questions on the reproducibles, found on pages 14 and 15 in this teacher's guide. To match these time codes, set your VCR counter to zero at the beginning of the tape.)

Episode I: Hot Rods

After Segment 1 (3:38)
- How would you design a dragster for maximum acceleration? Sketch your design and describe its features (engine, overall weight, tire size, etc.).
- Look for evidence of teamwork during the video. Are conflicts resolved successfully?

After Segment 2 (16:07)
- After five hours, how have the teams balanced the power-to-weight ratio for their dragsters?
- How have the teams' plans changed because of materials or time limitations?

After Segment 3 (31:37)
- In your opinion, which team has the best-built dragster? Which team has the best overall design? Give evidence to support your answers.
- Predict which team you think will have the fastest dragster. Give reasons for your choice.

Episode II: Off-road Vehicles

After Segment 1 (5:02)
- Compare the designs the experts developed. Sketch and describe each team's basic design.
- Look for evidence of teamwork during the video. Are conflicts resolved successfully?

After Segment 2 (13:51)
- Record the strengths and weaknesses the judge sees in each team's design and construction.

After Segment 3 (21:09)
- Which team is further ahead in their construction?
- How have the teams' plans changed because of materials or time limitations?

After Segment 4 (32:40)
- In your opinion, which team has the best-built off-road vehicle? Which team has the best overall design? Give evidence to support your answers.
- Predict which team you think will have the fastest car. Which team do you think has the most reliable car? Give reasons for your choice.

Safety Considerations

Please do not send your students into junkyards for these or any other projects! Designing and building objects is a great way for students to learn engineering skills and apply science and design principles, but you must give them ways to do this safely.

Some options:
- Provide materials and building time in class (especially for younger students).
- Allow students to purchase their supplies or use supplies from around the house (with permission, of course) within strict guidelines set up in advance, including types of materials and cost.
- Encourage parents to teach their children correct use of tools, forbidding all power tool use except while an adult is present. Never use welding torches or chain saws!

Do not assign projects that use explosives, very large forces, extremely high air pressures, or unprotected sharp objects. Consider all the worst-case scenarios and set your guidelines accordingly. As a general principle, design projects that are based on finesse or accuracy instead of raw power.

Assessments

Included in this guide are two assessment rubrics: one for the general evaluation of students in laboratory situations and one for the *"Self -propelled Car"* project. Make a transparency or copy of the rubrics to share with students ahead of time; they must know the criteria on which they will be evaluated.

The general rubric *"Indicators of Student Involvement"* is designed for use during Classroom Challenges #1–3. Realistically, you can evaluate two to four students per lab period. During the course of a quarter, make sure every student is evaluated at least once. But here's the key: Don't let the students know who is being observed in any particular lab period.

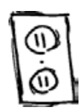
For the car project, feel free to weight the criteria shown along the left column as you see fit. You may wish to emphasize or de-emphasize the importance of the journals, or replace the journals with formal lab reports or technical drawings. You may also wish to replace the numerical goals for the students (10 penny-meters and above for the top score) with a more general ranking among the projects in your class that year.

For help in developing your own rubrics, visit the Web site *http://rubistar.4teachers.org/*. You'll find dozens of sample rubrics that you can adapt for many different applications in your classroom.

National Science Education Standards

The National Science Education Standards, published by the National Academy of Science, provide guidelines for teaching science in grades K–12, as well as a coherent vision of what it means to be scientifically literate.
To order the Standards, contact the National Academy Press, 2101 Constitution Ave. NW, Lockbox 285, Washington, DC 20005; http://books.nap.edu.
The activities in this teacher's guide address the following national content standards:

Science as Inquiry (grades 5–12)
- *Abilities necessary to do scientific inquiry*
- *Understandings about scientific inquiry*



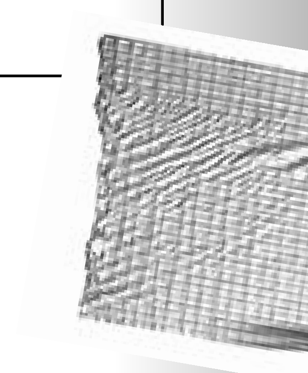
Physical Science (grades 5–8)
- *Properties and changes of properties in matter*
- *Motions and forces*
- *Transfer of energy*

Physical Science (grades 9–12)
- *Structure of atoms*
- *Structure and properties of matter*
- *Chemical reactions*
- *Motions and forces*
- *Conservation of energy and increase in disorder*
- *Interactions of energy and matter*

Science and Technology (grades 5–12)
- *Abilities of technological design*
- *Understandings about science and technology*

National Council of Teachers of Mathematics

The National Council of Teachers of Mathematics (NCTM) has developed national standards to provide guidelines for teaching mathematics. To become a member of the NCTM, or to view the Standards online, go to http://www.nctm.org.
This lesson plan addresses the following math standards for grades 9–12:
- *Algebra Standard: Understand patterns, relations, and functions; represent and analyze mathematical situations and structures using algebraic symbols; use mathematical models to represent and understand quantitative relationships.*
- *Measurement Standard: Understand measurable attributes of objects and the units, systems and processes of measurement; apply appropriate techniques, tools, and formulas to determine measurements.*



CLASSROOM CHALLENGES

#1: DUNE BUGGY LAB

Background Information
Any constant velocity toy can be used here. The toy dune buggies are available by mail order or from toy stores for about six dollars each. To adjust the speed of some of the buggies, remove one battery and replace it with copper pipe (with end caps) cut to match the length of the battery

This lab is a good time to discuss experimental error, since the dune buggies are far from ideal vehicles, and the method of collecting data looks pretty crude to the students. But with reasonable care, the data does form very good straight lines and interpreting the slopes and intercepts will be enlightening to the students.

Materials
- toy dune buggy
- stopwatch
- position markers (coins or self-sticking notes)
- meter sticks or metric tape

Objective
Students will study the graphs and equations that describe constant motion

Procedure

1. Mark a point of origin on the floor with a coin or self-sticking note. Start the dune buggy several centimeters behind this point. When the dune buggy reaches it, start the stopwatch. Have a student call time every three seconds and another student in the group mark the position of the dune buggy. Continue for 18 seconds.

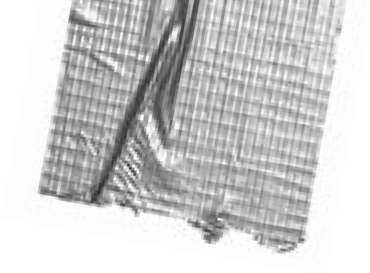
2. Measure the position of the dune buggy at each time, making all measurement from the point of origin.

3. Repeat twice, for a total of three trials. Write the results in Data Table 1.

4. Measure a position four meters away from the origin. Start the dune buggy several centimeters beyond four meters, heading back toward the origin. Start timing when the dune buggy reaches the four-meter mark, and continue as directed above. Measure the position again from the origin, and complete three trials. Write the results in Data Table 2.

Data Table 1

Time (s)	0	3	6	9	12	15	18
Position-m Trial 1							
Trial 2							
Trial 3							
Average Part 1							



Data Table 2

Time (s)	0	3	6	9	12	15	18
Position-m Trial 1							
Trial 2							
Trial 3							
Average Part 2							

Analysis

1. Calculate the average position for each time. Make a graph of position (on the y axis) versus time (on the x axis) for each part.

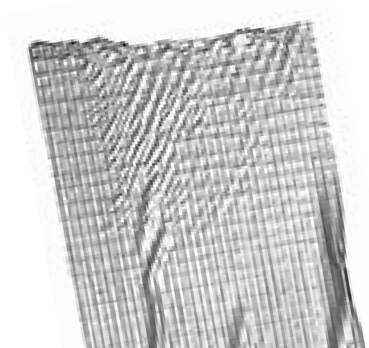
2. Determine the equation of each line. Write the equation on the graph.

a. What is the value of the slope for Part 1? What does it tell you about the motion of the car?
(Answer: The slope will vary from group to group, but emphasize to the students that they must find the numerical value and units for the slope. The slope indicates the velocity of the car in units of meters per second.)

b. What is the value of the slope for Part 2? Why is its sign different from the slope in Part 1? How does its absolute value compare to the slope in Part 1? Why?
(Answer: The numerical value for the slope in Part 2 should be nearly the same as in Part 1, but with the opposite sign because the car is traveling at the same speed but in the opposite direction.)

c. What is the intercept in Part 1? What does it tell you about the motion of the car?
(Answer: The intercept (with units) should be nearly 0 m. It indicates the starting position of the car.)

d. What is the intercept in Part 2? Why is it different from the intercept in Part 1?
(Answer: It should be about 4 m, because that is where the car started in Part 2.)



#2: KINEMATICS OF A STUDENT

Background Information

This is a low-tech, high-activity introduction to velocity and acceleration. The data collected for this experiment tends to be fairly unreliable, however, so be prepared for many repeated trials until the timers learn to start and stop their stopwatches correctly.

Part 1

Objective

Students will work in groups of about six students. Tell them that they will travel one at a time in a straight-line path and *attempt to maintain a constant velocity.* While one student walks, jogs, or runs, the other group members time the "runner" while standing at five-meter intervals along the path. Start timing when the runner starts; stop when the runner passes your point.

Have one person in the group record data from the timers immediately after each run.

Data and Map of the Course

Start

5 m / Timer 1 _______________

10 m / Timer 2 _______________

15 m / Timer 3 _______________

20 m / Timer 4 _______________

Calculations

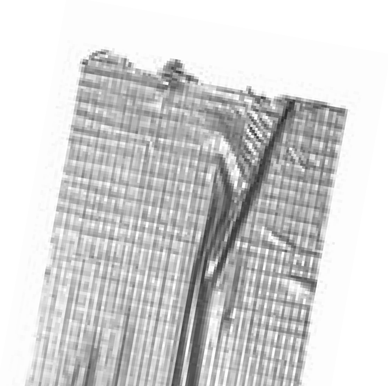
1. Make a d-t graph, using **d** (on the vertical axis, even though it's your independent variable) versus **t** for your motion. Draw lines to "connect the dots" on the graph instead of making a traditional smooth curve. Since the time was started as you passed the starting line, you should also include a (0 s, 0 m) point on your graph.
2. *On the same graph,* using different colors or other distinguishing marks, graph the motions of two other people in your group as well. Again connect the dots of each graph separately.
3. Calculate the slopes for each interval (between each two consecutive points) of your graph. These are your average velocities. List these values in the Results table below. Also calculate the mid-time of each interval using $\mathbf{(t_1 + t_2)/2}$, and record those values in the table.
4. Make a graph of average velocity (V) (vertical axis) versus mid-time velocity using the same scale along your time axis. Do not include a (0 m/s, 0 s) point on this graph, unless you tried to start with zero velocity.

Results table

Intervals	My V	Mid-time	_______'s V	_______'s V
0–5 m				
5–10 m				
10–15 m				
15–20 m				

Questions

1. Was your velocity constant? Defend your answer. *(Answer: Constant velocity is indicated by a straight line on the graph of d versus t.)*
2. Who moved the fastest? How did that person's d-t graph compare to the others? *(Answer: The fastest traveler had the steepest slope.)*



Part 2

Objective

In this part of the experiment, you will travel in a straight-line path and try to move with a *constant positive acceleration.* In other words, you want to increase your velocity steadily. While each person walks, jogs, and then runs, the other group members time them standing at five-meter intervals along the path. Collect your data as in Part 1.

Data and Map of the Course

Start

5 m / Timer 1 _______________

10 m / Timer 2 _______________

15 m / Timer 3 _______________

20 m / Timer 4 _______________

Calculations

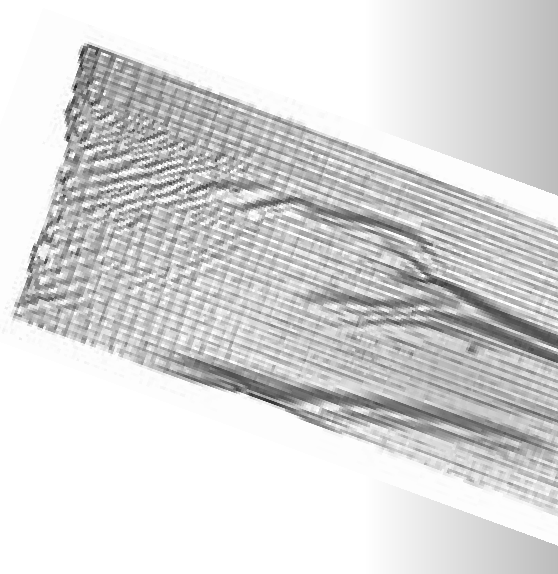
1. Make a graph of **d** (on the vertical axis again) versus **t** for the first trial. Again connect the dots on your graph instead of making a smooth curve.
2. Calculate the slopes for each interval (between each two consecutive points) of each graph. These are your average velocities. List these values in the Results table above. Calculate your mid-times and record on the table.
3. Make a graph of average v (vertical axis) versus mid-time using the same scale along your time axis as on your d-t graph.

Results table

Intervals	Average Velocity	Mid-time
0–5 m		
5–10 m		
10–15 m		
15–20 m		

Questions

1. What is the basic shape of your d-t graph? How does it compare to the d-t graph in Part 1?
   (Answer: The graph in Part 2 looks like the right-hand side of a top-opening parabola, which is different from the straight line we get at constant velocity.)
2. What trend do you see for the velocities on your graph?
   (Answer: The velocities should steadily increase as the runners move through the course.)
3. Describe the motion that is required for a person to move with a constant positive acceleration.
   (Answer: A person's velocity must steadily increase; he or she must move faster and faster.)



#3: MASS AND ACCELERATION LAB

Background Information
This lab uses a lot of equipment, so you may choose to do this as a class with everyone collecting data together at one station. If you prefer individual lab groups, but don't have enough carts, simply have students measure the mass of the carts and record the mass in kilograms, then add known masses to the cart each time.

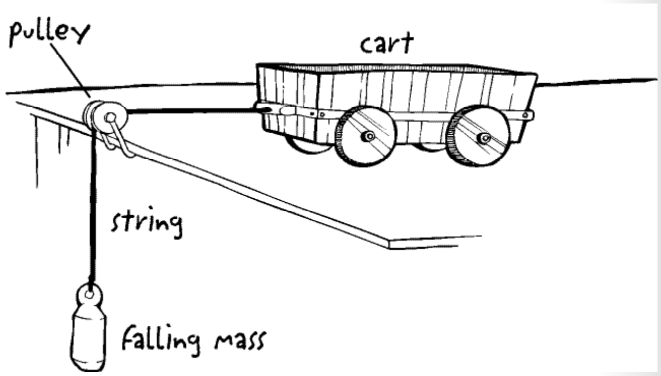
For timing, you can use stopwatches or set up photogates with the appropriate computer connection.

The carts that work best for this lab are the old, very strong dynamics carts, usually made with metal wheels and heavy wood or plastic chassis.

Students usually get a good inverse relationship for this experiment, which shows that as the mass of the accelerating object increases, its acceleration decreases.

Important discussion should take place as part of the post lab about the choices automobile manufacturers make in matching the size and strength of the car chassis to the force the engine can provide to the wheels.

Objective
Investigate the effect of changing the mass of an accelerating system.

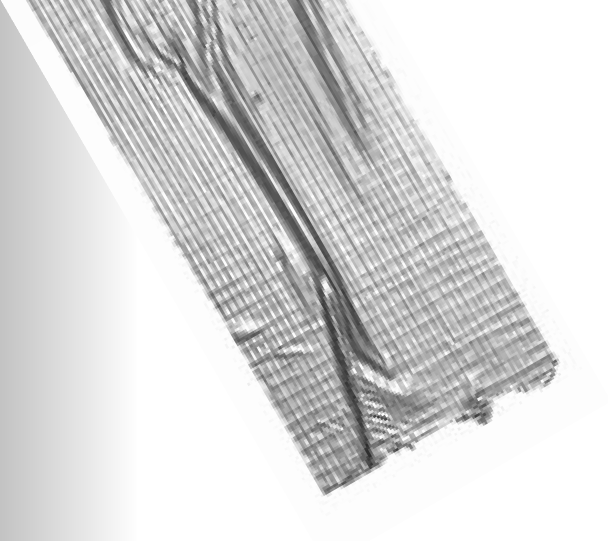


Setup

1. Set up the equipment as in the illustration above. Using masking tape, mark a distance of about one meter along the tabletop that shows the starting and ending positions of the cart as the mass is falling. Timing should start when the cart is released and end as the falling mass hits the ground (or better yet, a piece of foam rubber on the ground). Measure the distance you will use and record that value in meters in the data table below.
2. Time the cart as it moves across the tabletop, starting from rest at the starting point. Repeat twice for a total of three trials.
3. Double the mass of the cart by setting another identical cart on top of it. Repeat the time measurements.
4. Increase the mass by adding a third cart, then a fourth cart and repeating the time measurements.

Data Falling Mass ________________ Displacement along track _______________

Mass (Carts)	Time 1 (s)	Time 2 (s)	Time 3 (s)	Average Time (s)	Calculated Acceleration (m/s^2)
1					
2					
3					
4					



1. To calculate the acceleration, use $\mathbf{d} = \mathbf{v_i t} + \frac{1}{2}\,\mathbf{at}^2$
2. Graph acceleration (vertical) versus mass (horizontal) using a graphing calculator.
3. Sketch the graph here, including axis labels, title, and largest and smallest numbers.
4. What function does this graph indicate?

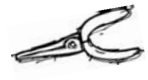
RUBRIC

Classroom Challenges #1-3

Indicators of Student Involvement

Categories	0-1 point	2-3 points	4-5 points
Intellectual Curiosity and Spirit of Investigation	● Fills in lab sheet only ● Asks no questions or irrelevant questions; answers no questions ● Not involved with lab ● Does not complete experiment	● Makes effort to understand the lab ● Asks and answers clarifying questions about the lab ● Mostly involved ● Completes lab as directed ● Passive participation	● Strives for complete understanding ● Asks and answers probing questions that extend understanding ● Full, active participation ● Goes beyond intended activity
Personal Responsibility	● Tardy or significant time wasted ● Careless with equipment or does not handle equipment at all ● Does not follow safety ● Cleans up insufficiently ● Unprepared for lab activity	● Time wasted or does not complete lab ● Some carelessness or risky procedures ● Cleans up partially	● Makes good or excellent use of time ● Uses lab equipment and facilities responsibly ● Cleans up completely ● Prepared for class, has needed materials for activity
Group Dynamics and Interactions	● Does not contribute to group ● Minimal or negative interactions ● Creates or encourages unrelated activities or discussions	● Some contribution to group understanding ● Mostly receptive to ideas and opinions of others ● Creates some distractions	● Contributes to group understanding through questions or explanations ● Makes sure everyone in group understands ● Receptive to ideas and opinions of others ● Makes effort to reduce group distractions

#4: SELF-PROPELLED CAR



Three-person teams will design, construct, and test cars to run faster and farther than the other cars in the class. The majority of the points earned are based on the car's distance and speed.

Rules of Competition

1. When placed on the starting line, a car must start under its own power and run only on the flat surface of the floor (no flying). You may release your car from the start line, but after releasing it, you may not touch it again.
2. You may not push your car. You will be allowed to hold the car down and let go or release a switch or trigger. You may never impart a force on the car in the direction of motion.
3. The car's power must ride on the car itself. You may not use a launching device such as a ramp or slingshot.
4. No electrical, chemical, animal, or commercially available motors are allowed.
5. No carbon dioxide cartridges, dangerous chemicals, rocket engines, or explosives are allowed.
6. No pre-manufactured car bodies may be used.
7. No pre-manufactured wheels may be used. This means you may not use any items for wheels that were pre-manufactured *for this purpose.*
8. All contestants must have pretest data results. That is, you must test your final product on your own time a minimum of 10 times prior to the final race. Record distance traveled and time; then calculate the average displacement and speed. A data table containing this information is due the day of the race.
9. Part of the grade in this project comes from the design, solid construction, and beauty of your car. Be creative when you are designing and building the car.
10. Possible propulsion energy sources include a falling weight, a mousetrap, and stretched or twisted elastic materials such as rubber bands or bungee cords.

Scoring

This project is worth 100 points, distributed as follows: 5 points for aesthetics, 15 points for pretest data tables, 20 points for the report, and 60 points for the race score. The race score is calculated with the following formula.

- **10 points** if your car moves one full car length
- **30 points** for the most distance traveled: The car that goes the farthest receives all 30 points and each car thereafter is scaled from there. The last car will receive 10 points.
- **20 points** for being the fastest car: The car that goes the fastest will receives all 20 points and each car thereafter is scaled from there. The slowest car will receive 10 points.

Modifications

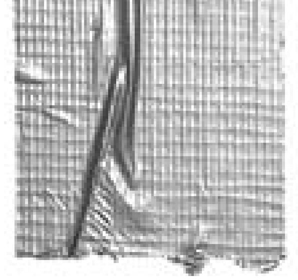
You may wish to provide materials such as Pinewood Derby or mousetrap car kits to younger students, modifying the rules appropriately. Several vendors have these available; see the Web sites on page 13.

For greater uniformity, limit your students to one type of propulsion system whereby everyone uses one mousetrap or everyone uses 20 #10 rubber bands. This allows you to minimally change the project requirements every year.

Advanced students may want to try the extension below.

Extension: Scrambler

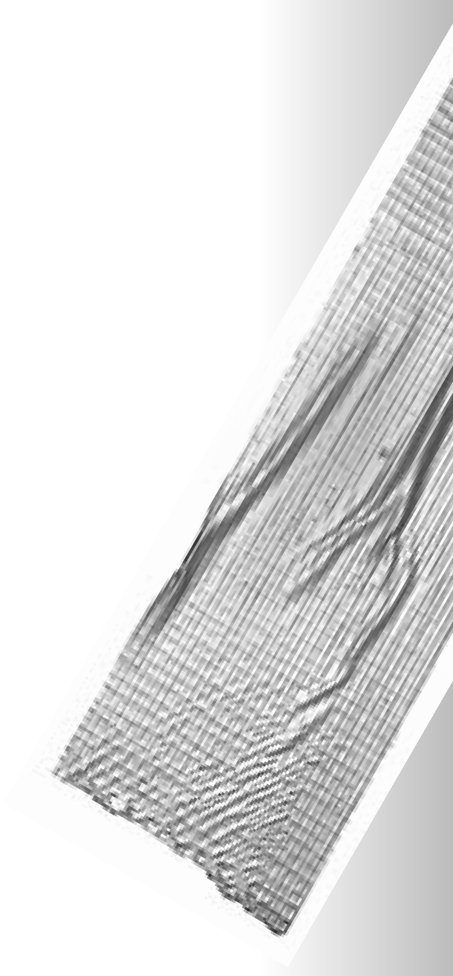
Increase the complexity of the contest by requiring students to make cars that also travel a predictable distance. Add a requirement that they must construct a place for an egg to be attached to the front of the car. At least half the egg must protrude beyond the "egg case." Place a wall (or a heavy table on its side) at the position the car should stop; students must know in advance how far a car will travel to place the wall in the correct location.



Objective
Have a car travel as close as possible to the wall without breaking the egg.

Rules
Students may not use any cushioning device behind the egg. The back of the egg must rest against a solid surface.

Grading
The highest number of points is earned by stopping the car closest to the wall. The perpendicular distance of a car from the wall will be measured in centimeters. The car's stopping distance from the wall divided by the total distance the car traveled will be the "error ratio." The smallest error ratio will receive the highest number of points, and the other cars will receive a proportionate downward ranking. Any car that hits the wall and breaks the egg will lose all points. A very light tap into the wall that does not break the egg earns the highest number of points.



Evaluation Rubric

Self-propelled Car

Categories	0-1 point	2-3 points	4-5 points
Function (Quantitative)	0-1.9 meters	2-2.9 meters	10 or more meters
Function (Motion)	Does not move, or moves backward or sideways.	Moves forward, but slowly or with significant curvature.	Moves forward swiftly.
Plan and Technical Drawing	Plan does not show measurements correctly, is not to scale, or is drawn or labeled inaccurately.	Plan provides clear measurements and labeling for most components. Drawing is clear, though scale may be slightly inaccurate.	Plan is neat with clear measurements, labeling and scale correct for all components.
Construction	Construction appears careless or haphazard. Many details need refinement for an efficient or attractive car.	Construction was fairly careful and accurately followed plans, but two or three details need refinement for an attractive and efficient car.	Great care taken in construction so the car is neat and attractive and follows plans accurately.
Scientific Knowledge	Explanations by the majority of group members do not illustrate much understanding of the scientific principles applied in the car's design and construction.	Explanations by the majority of group members illustrate mostly accurate understanding of the scientific principles applied in the car's design and construction.	Explanations by all of the group members illustrate clear and complete understanding of the scientific principles applied in the car's design and construction.
Individual Journal (Content)	Journal provides very little detail about the planning, construction, and testing process of the car. Does not reflect group dynamics and division of labor.	Journal provides much detail about the planning, construction, and testing process of the car and provides some reflection on group dynamics and division of labor.	Journal provides a complete record about the planning, construction, and testing process of the car, including reflection on strategies and the reasons for modifications and innovations. Clearly discusses group dynamics and division of labor.
Individual Journal (Appearance)	Few entries made; they are not dated or are too messy to read.	Several entries made; most are dated and legible.	Several entries made; all are dated and neat.

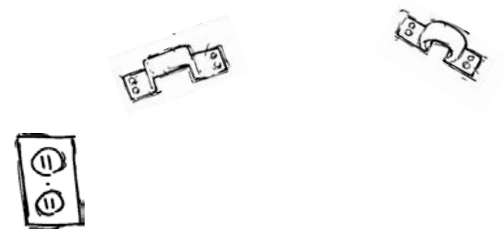
WEB SITES

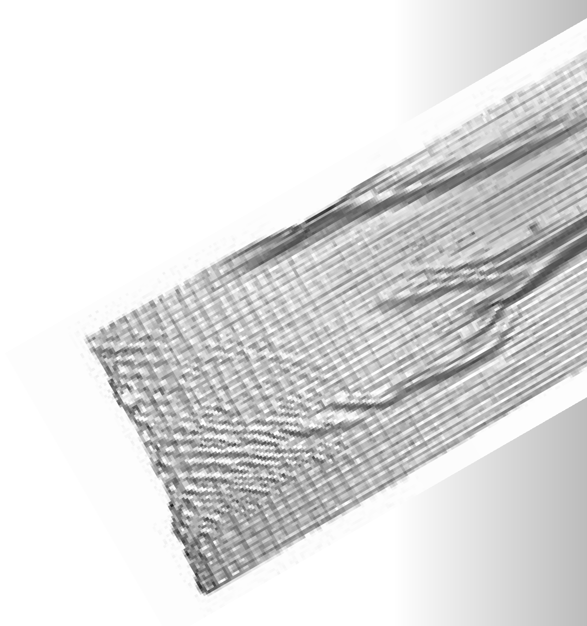
Teachers and students may find the following Web sites informative while working on the Classroom Challenges.

- *http://www.pitsco.com.* (This company sells many dragster kits at reasonable prices.)
- *http://www.ltsa.org/pdfrules/Dragster%20Design.pdf.* (Features detailed rules for a carbon dioxide-propelled dragster competition)
- *http://www.docfizzix.com/mousetrap-cars-boats-racer-books.htm.* (This company sells designs for mousetrap-powered cars and others.)
- *http://www.cooz.com/co2/welcome.htm.* (A terrific teacher-created resource for students building a carbon dioxide-propelled dragster.)
- *http://www.nas.nasa.gov/About/Education/Racecar/.* (A great site for learning about aerodynamics in race car design)
- *http://www.essentialschools.org/pubs/exhib_schdes/nyac_web/mineola/vision.htm.* (Includes detailed set of mousetrap-powered car rules)

To see Junkyard Wars on DiscoverySchool.com, visit the Web site below.

- *http://school.discovery.com/networks/junkyardwars* (Interactive games and puzzles; ideas for challenges, projects, and activities; and other teacher resources support the Junkyard Wars Classroom Video Kits.)





Episode I: Hot Rods Name___________________________

After Segment 1

- How would you design a dragster for maximum acceleration? Sketch your design and describe its features (engine, overall weight, tire size, etc.).
- Look for evidence of teamwork during the video. Are conflicts resolved successfully?
- Compare your design to the experts' proposals. Does your design look more like Joe's or like Sean's?

After Segment 2

- After five hours, how have the teams balanced the power–to–weight ratio for their dragsters?
- How have the teams' plans changed because of materials or time limitations?
- What are the problems the judge finds with each team's construction so far? Watch the next part to see how and if the teams correct these design flaws.
- Continue to record instances where you see team members resolving conflicts or supporting each other's work.
- How do the teams steer their cars? Describe or sketch the different designs chosen.

After Segment 3

- In your opinion, which team has the best-built dragster? Which team has the best overall design? Give evidence to support your answers.
- Predict which team you think will have the fastest dragster. Give reasons for your choice.
- Describe the results for each team in sentences.
- Record the times for each race below:

Race	Chicago Fire	Scrap Daddies
1		
2		
3		
Average		

- Circle the winning time.
- Calculate the average time for each team. If average times had been used, would the winner be the same?

Episode II: Off-road Vehicles Name______________________

After Segment 1

- Compare the designs the experts developed. Sketch and describe each team's basic design.
- Look for evidence of teamwork during the video. Are conflicts resolved successfully?
- Watch the team members and their construction techniques. Look for and record examples of unsafe procedures that should be avoided.

After Segment 2

- Record the strengths and weaknesses the judge sees in each team's design and construction.

After Segment 3

- Which team is further ahead in their construction?
- How have the teams' plans changed because of materials or time limitations?
- Continue to record instances where you see team members resolving conflicts or good communication between team members.
- Continue to look for examples of unsafe procedures.

After Segment 4

- In your opinion, which team has the best-built vehicle? Which has the best overall design? Give evidence to support your answers.
- Predict which team you think will have the fastest car. Which team do you think has the most reliable car? Give reasons for your choice.
- Describe the results for each team in sentences.
- What driving skills and driver choices during the race affected the outcome of the race?
- How did the different designs work during the race?
- Record the winning time.

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