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Matchbox Cars PQRST

A 3-dimensional unit on racing Matchbox cars highlighting famous women in car racing. Swedish racing icon, Ewy Rosqvist, was the first woman to win the Grand Prix. Puerto Rican lead engineer, Alba Colon, is one of the highest ranking females in the world of motor sports.

2018 Arizona Science Standards (AzSS)

This lesson is most appropriate for students from 3rd-8th grade but could be utilized with students younger and older. It is fantastic for engaging students with the science and engineering practices, which is good for any grade level. However, it ties most directly with the specific standards shown below.

AzSS: 1.P3U1.3 – Plan and carry out investigations which demonstrate how equal forces can balance objects and how unequal forces can push, pull, or twist objects, making them change their speed, direction, or shape.

AzSS: 5.P3U1.4 – Obtain, analyze, and communicate evidence of the effects that balanced and unbalanced forces have on the motion of objects.

AzSS: 5.P3U2.5 –Define problems and design solutions pertaining to force and motion.

AzSS: 7.P3U1.3 – Plan and carry out an investigation that can support an evidence-based explanation of how objects on Earth are affected by gravitational force.

AzSS: 7.P3U1.4 – Use non-algebraic mathematics and computational thinking to explain Newton's laws of motion.

Materials

PQRST Journals for each student
Ramps (can be tables elevated at one end, foam boards, or any other inclined plane)
Matchbox Cars (even better if they are either modeled after Ewy Rosqvist's car or NASCAR race cars)
Tools for measuring distance – rulers, measuring tapes, meter sticks, etc.
Tape
Pennies or paperclips for use as weights.
Protractors for measuring angles.
Graphite – from a pencil (NOTE: It is NOT lead.)

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Video Introduction to Racing Icon

Give students 5-10 minutes to draw the picture of a racecar driver.

Next, show this video about the kind of toys 1st grade girls select when given an option and how we might change that. Don't mention what the video is about. Just play it.
Mercedes-Benz x Matchbox: No Limits (http://bit.ly/MatchboxForGirls)
Ask students to discuss what they saw in the video.
You might prompt them with questions like:

- Why do you think the girls in the video didn't pick the car to begin with?
- Are there some toys only boys should be allowed to play with?
- Are there some toys only girls should be allowed to play with?

Ask students if they would like to see the video they showed the girls about Ewy and then show it to them.
Ewy Rosqvist: An Unexpected Champion (http://bit.ly/EwyRosqvist)
Ask students to discuss what they just saw in the video about Ewy.
You might prompt them with questions like:

- What challenges did Ewy face?
- Do girls race cars?
- What is inspiring about Ewy's story?
- How hard to you think Ewy worked to become a great car racer?

Part 1: Let's Science a Racing Matchbox Car

Phenomenon – simply roll a Matchbox car down a ramp, which then continues onto a horizontal surface. You can repeat this a few times if necessary.

Journal Page 1: Have students draw and label a picture of what they just saw. They should also complete "I notice…" statements about what they observed.

Questions

Journal Page 2 & 3: Students should now generate as many questions as they can related to the car rolling down the ramp and eventually comping to a stop. They should work silently to begin with and then after they have all had some individual think ink time, they can share questions with small groups.

Once students have had 5-10 minutes to generate questions, have them share out their questions one at a time and write them on poster paper or your "Wonder Wall". Let them exhaust their ideas and don't discount any questions they have. If you have a particular learning path in mind, you can either pose your own questions or mention an observation, which might get at questions you want students to investigate.

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Some questions we expect:

1. I wonder why the car comes to a stop?
2. I wonder if we could make the car travel further before it stops?
3. I wonder what determines how far the car will go?
4. I wonder if this car is modeled after a real car?
5. I wonder what would happen if we changed the mass of the car?
6. I wonder what ramp angle will make the car travel the furthest. I can't tell difference between some colors when I was sorting?

You may want to categorize your questions into groups. The groups might include:

- **Fact-Check Questions** – can easily be looked up in a book or online resource.
- **Scientifically Testable Questions** – can be investigated using the Science & Engineering Practices. The constraint on testable questions is the equipment/supplies/measurement devices you have available.
- **Claim, Evidence, Reasoning (CER) Question** – is a question which can be explained after the phenomenon has been investigated with a claim about the answer, supported with evidence from the research conducted, and reasoned out based on the model established.
- **Beyond Science Questions** – are connected to other subject areas and are not testable using science

Journal Page 4: Show students all the materials and equipment available for them to use related to this phenomenon. This could include things like tools for measuring distance, digital scales for measuring mass, pencils, different Matchbox cars, ramps of different kinds, different floor surfaces, and so on. They can also brainstorm other materials and equipment they might have which could be used during an experiment related to the cars.

Give students time to tinker and play with the materials and equipment they have access to for the research investigation. After they have had time to see firsthand how everything works, they should write down additional observations in the "I notice…" section.

Journal Page 5: Allow students time to think of even more questions they might have related to racing Matchbox cars now that they have had time to tinker will all the supplies for a bit. Additional questions should be added to the Wonder Wall.

Research Investigation – using Science & Engineering Practices

Journal Page 6: Note the research investigation will be constrained to the Matchbox car rolling down a ramp and then onto a horizontal surface. Given that setup, have students brainstorm Independent Variables and Dependent Variables.

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Teacher Backgrounder: Independent Variables are variables, which can be manipulated or changed by the experimenter – think "I" control Independent Variables. Dependent variables are responding variables which could vary or change depending on other factors. Dependent Variables can be thought of as a result or consequence of the experiment. Dependent Variables are measured and/or calculated with available equipment. Control Variables will be discussed later. If you need more background, review this video from The Wonder of Science: http://bit.ly/ScientificInvestigationVideo

Journal Page 7: Now that students have brainstormed all the independent and dependent variables, it is time to come up with a testable question. Students should select one independent variable they want to systematically change during their experiment and one dependent variable they can measure. They should also fill in all the hypotheses on page 7 now that they have selected the variables they will be testing.

Journal Page 8: On this page, students need to draw and label a diagram of how they are going to set the experiment up. They also need to list the materials and equipment they will be using for their experiment. This is only what they are using and not a list of everything they have access to in the classroom.

Journal Page 9: On this page, students need to write a detailed experiment procedure. The procedure should be detailed enough so I could read it and carry out the experiment exactly the way they are imagining it going. I shouldn't have to ask any clarifying questions about what does this mean or how exactly is the ramp set up. The experimental procedure is also where every single variable listed on the Independent Variable list on page 6 needs to be given a set or controlled value. As an example, they are probably not going to switch out their Matchbox car. So, that will be set and a complete description of exactly which car they are using should be given. You can also have them go back to page 6 and list the values or settings for the Control Variables there. The only variable that should be changing is the one, and only one, Independent Variable they picked to test.

Journal Page 10: This is their data table. Note that units need to be included in the column headings but not with every number in the table below. As an example, if the independent variable was the height of the ramp, then a student could write Ramp Height (cm) as the title of the first column. Then, they could simply put 10, 20, 30, 40, 50, etc below that heading. It is implied that all the measurements in that column are in centimeters. It is best to have at least five trials or data points at each setting. This can be reduced if there is a crunch for time. These trials should then be averaged.

NOTE: If there is time and you want students to start to really analyze their data, you can go beyond average and have them calculate standard deviation and standard error for their data. This helps tell a more complete story and make claims which are supported more by the evidence. This lesson, called Beyond Average, can help with the mathematics and analysis of data.

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https://stemazing.org/beyond-average-standard-deviation-and-standard-error/

Journal Page 11: Students should label and create a graph of their data. This is where it will be nice to have students in groups to reference the data table while making this graph.

Journal Page 12: Once the graph has be labeled and created, students should spend time making observations about the data. They can look at patterns they see in the raw data and also in the graph. Questions you could use to prompt their thinking include:

- What patterns do you see in the data?
- Does it appear to create a linear (straight line) trend or a curve?
- What do you think the graph would look like if we kept extending it? Can you extrapolate the data to make a prediction?
- Is there any indication one or more of the data points could be off for one reason or another?

Science Story

Journal Page 13: It is now time for students to make a claim based on evidence. They should look back at their hypotheses and rewrite the hypothesis that seems to match the data as their claim. If none of the hypotheses matches the data, then they should write a new claim.

Next, students need to cite evidence from their data which supports their claim.

Journal Page 14: Students need to consider the reason why their claim was supported by evidence. What is the science which caused this to happen? What is the reason behind the behavior they observed in their experiment?

If there is time, this is a nice place for peer critique. Let another student look over the CER and provide feedback and insight.

Thinking more…

Journal Page 15: Any good experiment should lead us to more questions. Let students record any new wonderings they have about Matchbox car racing.

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Extension:

Introduce students to Alba Colon, a Hispanic dynamo who is one of the highest ranking women in motor sports. These two videos are both great portraits of her. One is longer than the other, so that might influence which video you use.

Alba Colon has a career on the fast track as a female engineer at Chevy Racing
http://bit.ly/AlbaColonLong (9:42)

Alba Colon Feature GM Engineer
http://bit.ly/AlbaColonMedium (4:13)

Women in NASCAR: Alba Colon (1:18)
http://bit.ly/AlbaColonShort

Introduce students to an engineering secret Alba Colon would like as an engineer. To make cars faster, you have to try to reduce friction in any way you can. Ask students to think about what Alba might already be doing to reduce the friction on race cars. Now, let students re-run one or two data points using the same Matchbox car and setup, but this time have them put graphite on the axels of the Matchbox car. Graphite is a phenomenal lubricant. It will reduce the friction enough to help the Matchbox car travel significantly further than without it. Only one way to find out, TEST it!