DAYTONA VS. ROCKINGHAM

Performance Standards 12D/11B/13B.I

Students will apply the concepts, principles and processes of technological design to investigate motion relationships in natural and forced settings accordingly:

- *Knowledge:* describe various dimensions of forces involved in historic and progressing racing car designs.
- *Application:* design and test models which measure or modify the forces associated with center-of-mass factors in race car design.
- *Communications:* correlate the principles of torque and center of mass in equilibrium studies of car design through history.

Procedures

1. ***In order to know and apply concepts that describe force and motion and the principles that explain them (12D); the concepts, principals and process of technological design (11B); and concepts that describe the interaction between science, technology and society (13B),*** students should experience sufficient learning opportunities to develop the following:
   - Examine historic engineering dilemmas driven by science and engineering principles associated with car racing.
   - Researching historical design barriers or circumstances for design changes.
   - Determine success criteria of technological design to investigate the stability of car design (center of gravity).
   - Sketch a progression of design schematics for center-of-gravity designs.
   - Propose logical sequence of steps in design construction.
   - Predict proportional scale for actual racecar parameters and materials.
   - Record reliable and precise data and anecdotal observations.
   - Analyze data to evaluate center-of-gravity investigation models.
   - Compare examples of balanced and unbalanced forces in racecars.
   - Explain torque and center of mass in relation to conditions of equilibrium.
   - Communicate evaluation report to generalize factors associated with stability and controlling center of gravity in model designs.
   - Generate possible applications of car design which incorporate additional scientific concepts such as:
     - Explain the dimensions of speed/time with directional units.
     - Compare speed, average speed, velocity, acceleration and momentum with racecar examples.
     - Associate advances in the past century in automobile design, which have resulted from force and motion concepts.

   Note to teacher: This activity relates to knowledge associated with Standard 12D, while addressing the Performance Descriptors for Stage I within Standard 11B. Additional connections to scientific technologies advanced in the past century and career decisions are applicable from Standard 13B. The highlighted activity is offered through

   http://www.superspeedway.com/eng/home.html

   and may be used with a 50-minute video available for $29.95. Permission for its use was granted. Activity 5 is highlighted for this example; sequencing multiple activities for this segment. An additional resource (27 pages of activities and explanations) is available from the Insurance Institute for Highway Safety, Understanding Car Crashes: It's Physics from website:

   www.highwaysafety.org

   Both automotive and auto body students need to understand how concepts like speed, force, torque, design and gravity are beneficial to the safe operation of cars. Any one of these can be detrimental if applied in excess. When and why cars crash are important for students to understand.
2. Have students review and discuss the assessment task and how the rubric will be used to evaluate their work.
3. Begin the assignment by discussing the design problem that occurs when designing a racecar in relationship to where its center of gravity is when it comes into the corner of a racetrack. Students can see that racecar design has evolved over the years making them more stable and able to corner better. Explain that racetracks have also evolved which has made center of mass in equilibrium even more important. Divide the class into groups of

two. Have them test rollover using the teacher's guide provided by superspeedway. They will construct a ramp with two pieces of cardboard hinged with tape. Make a ridge by taping a straw 2 cm (0.8 in.) above the hinge. Tape a protractor to the end of the cardboard that lies on the table to measure the angle. Have students build cars using milk cartons as bodies using paperclips as axles and wheels 1" in diameter made of cardboard. Groups should be given various ground clearances and then test the rollover angle by raising the cardboard recording the angle of rollover. Encourage students to then experiment by giving them 6 3/8 inch flat washers allowing them to place them at various places on their car making it more stable. Ask them to explain in terms of center of gravity and base area. Students should present their findings and make connections to the design of past, present and future race cars. This activity can be used to discuss how the banking of different tracks in the Winston Cup Series affects the speeds obtained on each track both from historic and current perspectives.

4. Evaluate each group's work using the Science Rubric as follows, and add the scores to determine the performance level:
   - *Knowledge:* The descriptions of applicable forces associated with racecar design were complete and correct.
   - *Application*: The model testing procedures were correctly followed, and the data collection and analysis was complete and accurate.
   - *Communication*: The correlations from race car design to the principles of torque and center of mass were well reasoned, through and well detailed.

Examples of Student Work

- Meets
- Exceeds

Time Requirements

- One-to-three class periods for explanation, construction, testing, evaluation and conclusions

Resources

- Free teacher's guide from http://www.superspeedway.com/eng/home.html
- Video: Super Speedway ($29.95) can be ordered from website (not required)
- Per team: Tape 2 pieces of cardboard 15cm x 15 cm, protractor, paperclips, cardboard wheels, 15 cm straw, 150 cm, 3 empty milk cartons, 6 3/8 flat washers
- Science Rubric

Possible extensions:

- Recreate Pinewood Derby testing from Cub Scout program to further test design modifications for center of mass, weight and banking alterations.
- Consider center of mass implications in speed skates and skating.
- Consider torque balance of race cars as relating to tire pressures, wheel alignment and tire size variations/placement on race car.
- Compare scale models of race cars by decades from 1900 to the current time, focusing on axle placement, weights and curve banking, etc.

SCIENCE RUBRIC

Exceeds - must receive no more than one 3 and the rest 4s in the other areas of the rubric.
Meets - may receive no more than one 2 and a combination of 3s and 4s in the other areas of the rubric.
Approaches - may receive no more than one 1 and a combination of 2s, 3s or 4s, in the other areas of the rubric.
Begins - must receive at least a 1 in all 3 areas of the rubric.

	KNOWLEDGE Knows and understands scientific terms, facts, concepts, principles, theories and methods.	**APPLICATION** Applies scientific knowledge, skills and methods to manipulate, analyze, synthesize, create and evaluate.	**COMMUNICATION** Communicates scientific knowledge and applications through writing, speech and visual displays.
4	• Descriptions of scientific terms, facts, concepts, principles, theories and methods are complete and correct.	• Applications are thorough, appropriate and accurate.	• Written, oral and/or visual communication is well organized and effective.
3	• Descriptions of scientific terms, facts, concepts, principles, theories and methods are mostly complete and correct.	• Applications are mostly thorough, appropriate and accurate.	• Most of the written, oral and/or visual communication is well organized and effective.
2	• Descriptions of scientific terms, facts, concepts, principles, theories and methods are somewhat complete and correct.	• Applications are somewhat appropriate and accurate.	• Some of the written, oral and/or visual communication is organized and effective.
1	• Descriptions of scientific terms, facts, concepts, principles, theories and methods are minimally present or correct.	• Applications are minimally appropriate and accurate.	• Little of the written, oral and/or visual communication is organized and effective.
0	• All descriptions of scientific terms, facts, concepts, principles, theories and methods are missing and/or incorrect.	• All applications are missing and/or incorrect.	• All of the written, oral or visual communication is missing and/or lacks organization.
Score			