OHIO PERFORMANCE ASSESSMENT PILOT PROJECT
Science Inquiry – 2009-2010 Pilot

Scoring Dimension	Level 1	Level 2	Level 3	Level 4
	Student work shows limited understanding of the processes of scientific inquiry.	*Student work shows some understanding of the processes of scientific inquiry.*	*Student work shows mastery in understanding the processes of scientific inquiry.*	*Student work shows outstanding mastery in understanding the processes of scientific inquiry.*
Collect and Connect Content Knowledge	▪ Significance of the topic is missing or unclear	▪ Significance of the topic is explained in general terms	▪ Significance of the topic is explained with specific examples OR cited information	▪ Significance of the topic is explained with specific examples, cited information, AND makes an explicit connection to a local or global issue
	▪ Information is gathered but is not current or relevant and there is little connection to the investigation topic	▪ Current, relevant, and sufficient information is summarized OR analyzed to provide background and context to the investigative topic	▪ Current, relevant, and sufficient information is summarized AND analyzed to provide background and context of investigation topic	▪ Current, relevant, and sufficient information is analyzed and synthesized to provide background, context, AND rationale for the purpose of the investigation
	▪ Scientific content is inaccurate (incorrect) OR irrelevant to the topic	▪ Accurate (correct) and relevant scientific content is presented but without much explanation	▪ Accurate (correct) and relevant scientific content is organized AND sufficiently explained	▪ Accurate (correct) and relevant scientific content is well organized AND integrated throughout providing insights into the inquiry
	▪ Credibility and accuracy (reliability) of the sources are not discussed	▪ Credibility and accuracy (reliability) of sources are mentioned	▪ Credibility and accuracy (reliability) of the sources are analyzed	▪ Credibility and accuracy (reliability) of sources are fully analyzed AND evaluated
	▪ Connection between scientific content and investigative purpose is missing or unclear	▪ Connection between scientific content and investigative purpose is general	▪ Connection between scientific content and investigative purpose is detailed, clear, and logical	▪ Connection between scientific content and investigative purpose is logical AND provides a strong basis for the rationale of the investigation

Revised in April 2010

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Design of Investigation	▪ Posed inquiry question is missing, unclear, OR cannot be tested.	▪ Posed inquiry statement is general AND can be tested or investigated	▪ Posed inquiry question is specific AND can be tested or investigated	▪ Posed inquiry question is specific and can be tested or investigated with challenging and/or original research
	▪ Articulates a prediction, but it has limited relationship to the inquiry question	▪ Articulates a reasonable prediction of the expected results, but with weak explanation	▪ Articulates a reasonable prediction to the inquiry question with a clear rationale	▪ Articulates a comprehensive prediction to the inquiry question with detailed rationale with specific examples
	▪ Design is not relevant to the stated inquiry (question/problem)	▪ Design addresses some aspects of the stated inquiry (question/problem)	▪ Design matches the stated inquiry (question/problem) and accounts for interactions between variables (e.g., multiple variables controlled)	▪ Design matches the stated inquiry (question/problem) and accounts for interaction of variables in an innovative way
	▪ Procedures/data collection methods are missing OR difficult to follow	▪ Appropriate scientific procedures/data collection methods match the inquiry question but are incomplete (cannot be replicated as written)	▪ Appropriate scientific procedures/data collection methods match the inquiry question AND can be consistently replicated	▪ Appropriate scientific procedures/data collection methods match the inquiry question, can be replicated, AND provides a logical rationale for the procedures selected
	▪ Variables (independent, dependent, controls, constants, if applicable) are not identified, unclear, OR incorrect	▪ Variables are correctly identified but operational definitions are inadequate or missing	▪ Variables are correctly identified with adequate operational definitions	▪ Variables are correctly identified with adequate operational definitions AND possible variable interactions are discussed
o Safety Issues or Procedures are not Applicable	▪ Safety procedures are missing OR some aspect of the experiment poses an immediate threat to the safety of the student or others.	▪ Safety procedures are mentioned but are incomplete.	▪ Safety procedures are complete but lack detail or specific instruction	▪ Safety procedures are complete AND provide detailed and specific instruction to allow someone else to follow

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Data Analysis and Interpretation **The term "data" refers to observational, quantitative, and/or information gathered from research sources** o Computation or Estimation Skills are not Applicable	▪ Data are missing or incomplete ▪ Data analysis is missing, unclear, OR not relevant to the inquiry ▪ Data tables and/or graphs are present but are not discussed as a part of the analysis ▪ Not known whether student used appropriate computation or estimation skills for analyzing data ▪ Descriptions of patterns and relationships between variables or research information is missing or inaccurate ▪ Interpretations are missing, OR are not consistent with the data	▪ Data are collected but some gathered data are irrelevant OR based on limited trials ▪ Data analysis is present and relevant to the inquiry but is incomplete OR incorrect ▪ Data tables and/or graphs are present and referred to as a part of the analysis ▪ Used inappropriate computation OR estimation skills for analyzing data ▪ Descriptions of patterns and relationships between variables or research information is attempted but may be incomplete ▪ Interpretations reflect the findings but lack connections to the inquiry and/or analysis	▪ Relevant observational or measurable data are collected from several repetitions of the investigation when possible OR relevant information sources ▪ Data analysis is complete, accurate, AND relevant to the inquiry ▪ Data tables and/or graphs are integral to the analysis discussion ▪ Used appropriate computation AND estimation skills for analyzing data ▪ Descriptions of patterns and relationships between variables or research information are complete AND accurate but with limited explanation ▪ Interpretations reflect the findings AND connect back to the inquiry and analysis	▪ Relevant observational or measurable data are collected from several repetitions of the investigation within a reasonable range OR multiple relevant sources when possible ▪ Data analysis is extensive, accurate, relevant to the inquiry, AND provides basis for interpretations ▪ Multiple representations of data (data tables AND graphs) are utilized and provide the foundation for the analysis ▪ Used appropriate computation and estimation skills AND provided a rationale and/or explained reasoning ▪ Descriptions of patterns and relationships between variables or research information are comprehensive with a complete explanation ▪ Interpretations are a critical reflection of the findings AND directly supports a response to the inquiry based on the analysis

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Draw Conclusions	▪ Conclusions are missing, unclear OR inconsistent with the analysis ▪ Impacts of possible sources of error (experimental OR research) and limitations of the data/information are missing OR unclear ▪ Scientific explanations are missing, unclear, OR inaccurate ▪ Discussion of implications of the results (application, policies, solutions, and/or social considerations) are missing OR unclear ▪ Additional questions or next steps for further research are not provided	▪ Conclusions are based on the analysis and interpretations but are general in nature OR do not discuss all the findings ▪ Impacts of possible sources of error (experimental data OR research) and limitations of the data/information on the conclusions are identified, but are not discussed ▪ Scientific explanations makes superficial connections between the relevant science content and the inquiry ▪ Discussion of implications of the results (application, policies, solutions, and/or social considerations) are general in nature ▪ Additional questions or next steps for further research are provided but not relevant	▪ Conclusions address all the findings AND makes direct connection to the analysis, interpretations, AND hypothesis, when appropriate ▪ Impacts of possible sources of error (experimental data OR research) and limitations of the data/information on the conclusions are identified AND explained. ▪ Coherent scientific explanations makes connections between the relevant science content and the inquiry ▪ Discussion of implications of the results (application, policies, solutions, and/or social considerations) are specific and detailed ▪ Additional questions or next steps for further research are provided AND relevant	▪ Conclusions specific address all the findings AND makes direct connection to the background information, analysis, interpretations, AND hypothesis when appropriate. ▪ Impacts of possible sources of error (experimental data OR research) and limitations of the data/information on the conclusions are explained AND suggestions are offered to minimize future errors ▪ Coherent scientific explanations draws on specific evidence from analysis and makes explicit connections between the relevant science content, and the inquiry ▪ Discussion of implications of the results (application, policies, solutions, and/or social considerations) are specific, detailed, and connected to the background information ▪ Additional questions or next steps for further research are provided, relevant, AND explained

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Communicate and Present Findings	▪ Communicates reasoning and findings but does not follow conventions of formal writing (e.g., spelling, grammar, pronouns, voice, punctuation, tone, etc.) for a lab report or scientific research paper. ▪ Visual representations (charts, data tables, graphs, maps, diagrams, photos, etc) are missing or inaccurate ▪ Work and ideas of others are not cited or footnoted within the text OR does not provide a list of references. ▪ Presentation does not address the intended audience	▪ Communicates reasoning and findings partially following the conventions of formal writing for a lab report or scientific research paper. ▪ Visuals representations are present but are missing key features or may be poorly organized. ▪ Work and ideas of others are inconsistently cited/footnoted within the text and provides a list of references ▪ Presentation is appropriate to the intended audience but lacks focus or organization	▪ Communicates reasoning and findings clearly following the conventions of formal writing for a lab report or scientific research paper. ▪ Visual representations are accurate (correct), complete, and organized ▪ Work and ideas of others are appropriately cited/footnoted within the text and provides a list of scientific sources ▪ Presentation is clear, concise, organized, and addresses the intended audience	▪ Skillfully communicates reasoning and findings clearly following all the conventions of formal writing for a lab report or scientific research paper. ▪ Multiple visual representations (are accurate (correct), complete, organized, and appropriately utilized ▪ Work and ideas of others are appropriately cited/footnoted using a variety of scientific sources listed in approved citation style ▪ Presentation effectively expresses the findings in a creative and engaging manner addressing the intended audience

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	Student work shows limited understanding of the processes of scientific inquiry.	*Student work shows some understanding of the processes of scientific inquiry.*	*Student work shows mastery in understanding the processes of scientific inquiry.*	*Student work shows outstanding mastery in understanding the processes of scientific inquiry.*
Reflect on the Learning Process	▪ Reflection does not provide information on content knowledge learned and/or the learning process while conducting the investigation ▪ Reflection on specific investigative skills learned and how understanding of scientific inquiry changed over the course of the investigation is missing or unclear ▪ Reflection on the nature of collaborative group work is missing or unclear	▪ Reflection provides superficial discussion of content knowledge learned and/or the learning process while conducting the investigation ▪ Reflection describes generally or incompletely the investigative skills learned or how understanding of scientific inquiry changed over the course of the investigation ▪ Reflection on the nature of collaborative group work is general in nature or incomplete	▪ Reflection describes specific content knowledge learned AND details of the learning process throughout the investigation ▪ Reflection describes in detail the specific investigative skills learned and how understanding of scientific inquiry changed over the course of the investigation ▪ Reflection includes specific strengths and weaknesses of the group with a discussion of how these strengths helped the group successfully complete the collaborative tasks and provide specific strategies to improve the group's interactions on future tasks	▪ Reflection describes specific content knowledge learned, details of the learning process throughout the investigation AND presents compelling evidence of personal growth as a result of the investigation ▪ Reflection on specific investigative skills learned and a discussion of how their understanding of scientific inquiry changed over the course of the investigation are specific, detailed, and supported with specific examples ▪ Reflection explains the specific strengths and weaknesses of the group with a discussion of how these strengths helped the group successfully complete the collaborative tasks and provides specific strategies that will lead to substantive improvement in future work

Ohio Performance Assessment Pilot Project (2009-2010)
Science Inquiry – Physics Performance Task

Designing Energy Efficient Vehicles
Student Materials

Introduction

In May 2009, President Obama set in motion a new national policy aimed at both increasing fuel economy and reducing greenhouse gas pollution for all new cars and trucks sold in the United States. The new standards require an average fuel economy standard of 35.5 mpg by 2016. These new standards are projected to save 1.8 billion barrels of oil over the life of the program with a reduction of approximately 900 million metric tons in greenhouse gas emissions. "President Obama is uniting federal and state governments, the auto industry, labor unions and the environmental community behind a program that will provide for the biggest leap in history to make automobiles more energy efficient," said Department of Transportation Secretary Ray LaHood. Achieving these standards will require a comprehensive understanding of the physics of motion, materials, and systems needed to improve the efficiency of transportation vehicles.

Your Task

You are an Advisory Board member for the National Automobile Industry (NAI). This diverse group of auto engineers, scientists, and environmentalists was commissioned to generate guidelines for improving fuel efficiency and reducing carbon dioxide gas emissions into the environment. Your team will research the specifications of an "energy efficient" car currently on the market. Once you have determined the key features for improving vehicle performance, your team will design and build a new vehicle and experimentally test the vehicles' efficiency. After analyzing the initial data of your vehicle's performance, your team will re-design, build, and test an "improved" version of your vehicle. Your team will use the experimental findings to make recommendations to the American Auto Industry for releasing a new fleet of energy efficient cars in 2012.

Task Overview

Task Part	What You Need To Do	Product
1	Research the specifications of an existing "energy efficient" vehicle	Lab Report
2	Design and build an energy efficient vehicle	
3	Test the performance of your vehicle	
4	Analyze and interpret your findings	
5	Design, revise ,and retest an "improved" vehicle	
6	Compare and contrast the performance of the "initial version" with the "improved version" of the vehicle (including calculations)	
7	Draw your conclusions	
8	Reflect on the findings	
9	Prepare a final report with a list of recommendations for the NAI	
10	Reflect on learning	Essay
11	Group Presentation	Optional *

*Your teacher will decide whether you will be doing this portion of the performance assessment task

Ohio Performance Assessment Pilot Project (2009-2010)
Science Inquiry – Physics Performance Task

Part 1: Select and investigate the specifications of an "energy efficient" car currently on the market. (**Team Activity**). As a team, select an "energy efficient" car that is currently available to consumers. Collect information from a variety of sources and discuss any potential bias within the documents. Your research should:

- Identify the name, model, and manufacturer of the vehicle;
- Describe the physical dimensions of the vehicle (length, width, height, weight, etc.);
- Explore why this vehicle is considered to be "energy efficient";
- Identify and describe all the features of your chosen vehicle that may affect its efficiency;
- Retain this data so you will be able to compare the characteristics of this vehicle to others in terms of energy efficiency.

Use the research information and your discussion with group members from Part 1 to write an individual introduction to your lab report on the major factors that impact the energy efficiency of a vehicle.

Part 2: Design and build an energy efficient vehicle. (**Team Activity**). Vehicle choices include Mousetrap Racer, Rubber Band Powered Car, CO_2 Car Kit, Solar Powered Car, Electric Car, Wind/Fan Car, Wind-Up Toys, Pull Back Car or another type with your teacher's approval. Using your team's knowledge about the factors affecting energy efficiency:

- Brainstorm the features of your vehicle using the list of factors you have just investigated;
- Make a drawing of your vehicle labeling all the parts and a list of materials needed to construct the vehicle;
- Write a description of a vehicle explaining the features of the vehicle and a rationale for why this will make a more energy efficient vehicle;
- Explain the connections between your vehicle design and Newton's Laws of Motion;
- Review your drawing and rationale with your teacher for approval;
- Build your vehicle and record any modifications that you make during the construction process.

Write a summary of the design features of your vehicle and the rationale for why these features will produce a more energy efficient vehicle. Include these items in the materials section of your lab report. Draw a picture or take a photograph of your vehicle.

Part 3: Test the performance of your vehicle. (**Team Activity**).

- Describe how you are going to determine the energy efficiency of your vehicle design. **Record the description in your lab report**;
- Clearly identify all the variables to be studied (independent and dependent variables including controls if applicable). **List and identify all the variables in your lab report**;
- Show your vehicle test procedures to your teacher to check for any safety issues. Once you have your teacher's safety approval, and then conduct your vehicle test.

Record your lab procedures and information collected in your lab report.

Part 4: Analyze and Interpret your Findings. (**Individual Activity**).This is an essential part of your investigation. You need to carefully examine the data you have collected and determine what you can say about the results of the investigation based on the evidence. Include the following steps in your analysis:

- Measure, calculate, and/or estimate an adequate number of the following characteristics of your vehicle so you can describe its performance when completing the course:
    a. Mass of the car
    b. Static friction
    c. Rolling or dynamic friction
    d. Average speed of the vehicle while completing the run on the course
    e. Final speed
    f. Typical acceleration during the first section (first meter, first quarter, etc) of the run
    g. Amount of energy that can be stored or extracted from the vehicle's "power" source
- Suggest likely energy transformations that have occurred during the vehicle's run over the prescribed course
    a. Measure these transformations OR
    b. Describe data that you would need to actually "prove" if your suggested transformations are correct
- Explain what it means to have an "energy efficient" vehicle and compare this to an "environmentally friendly" vehicle;
- Organize the data into charts, tables, and/or graphs where appropriate. Remember to properly label everything and provide a key/legend when applicable;
- Describe and explain any patterns and/or trends that you notice when examining the data;
- State in your own words the results from the experiment and specifically cite evidence from the data to support your explanation.
  Record this information in your lab report.

Part 5: Redesign, build, and test the performance your "improved" vehicle. (**Team Activity**).
Based on the performance and analysis of the data of your initial vehicle:

- Select one feature to improve the performance of your vehicle;
- Redesign your vehicle to try to improve the vehicle's performance;
- Build the "improved" version of your vehicle;
- Write a hypothesis using an "if...then....because..." statement that describes how your new design will improve the performance of your vehicle;
- Clearly identify all the variables to be studied (independent and dependent variables including controls if applicable);
- Using the same course, repeat your investigation to test your "improved" vehicle.

Write a summary of the re-design features of your "improved" vehicle and the rationale for why these features will produce a more energy efficient vehicle. Include these items in the materials and procedural sections of your lab report.

Part 6: Repeat the analysis (Part 4) for your "improved" vehicle. (**Team Activity**). Compare and contrast the data from your "initial" and "improved" vehicle and include your analysis in your lab report.

Part 7: Draw Your Conclusions. (**Individual Activity**).
Review your analysis and interpretations of the data and write the conclusion section of the lab report. In the conclusion be sure to:

- List your findings using data to support your statements and referring back to your hypothesis;
- Make connections between your findings and the appropriate scientific content;
- Discuss any potential sources of error and explain how that error might be eliminated or reduced in future investigations;
- Identify the limitations of the findings and explains how those limitations might be addressed in future investigations;
- **Record this information in your lab report**.

Part 8: Reflect on the Findings. (**Individual Activity**). Based on your conclusions, reflect and comment on:

- Potential implications from the investigation (applications, policy decisions, personal decisions, etc.);
- Another possible scientific explanation/interpretation of your findings and explain whether it is supported and/or refuted by the data;
- Any new questions or unanswered questions that were generated during this study that you would like to explore in future investigations;
- **Record this information in your lab report**.

Part 9: Write the Final Lab Report to the National Automobile Industry Leaders . (**Individual Activity**). You will need to submit a final lab report with your recommendations to the NAI Leaders. The formal lab report (get format from teacher) must include:

- Summary of your knowledge about energy efficient vehicles (Part 1 and 2);
- Description of your "initial" and "improved" vehicle (Part 2 and Part 5);
- Hypothesis with explanation of why you think modifying this feature will improve the performance of your vehicle (Part 5);
- Design of Investigation including a list of all variables, materials, and detailed procedures (Part 3 and Part 5);

- Presentation of data -Tables, Graphs, Visuals (Part 4 and Part 6);
- Analysis and Interpretations (Part 4 and Part 6);
- Conclusions including possible error, limitations, and future investigations (Part 7);
- Provide recommendations and cite evidence from your investigation to justify why your vehicle design is an effective solution;
- Check any written materials and visuals to ensure that you have used proper scientific convention ;
- Cite all of your references using the format selected by your teacher.

Part 10: Reflect on Your Learning. (**Individual Activity**)
Write an essay reflecting on your learning, specifically explaining what you:

- Learned about the factors affecting energy efficiency of vehicles and Newton's Laws of Motion;
- Discovered about motion, velocity, acceleration over the course of completing this performance assessment;
- Used as strategies for learning, thinking, and producing work that were effective and those that did not work so well;
- Leaned about investigative skills and/or your understanding of scientific inquiry;
- Contributed to your group work, the strengths of your team, and how the interactions within your group could be improved in the future.

Part 11: Present Your Findings – **OPTIONAL** (**Team Activity**)
You will be asked to make an oral presentation to the decision makers sharing what you learned from your investigations and making recommendations on the design of energy efficient vehicles. When preparing your presentation:

- Consider the audience, estimate their current knowledge of the topic, and prepare your material so they can understand your findings;
- Provide a clear overview of your investigation (purpose, procedures, analysis, and findings) so that it has a impact on the audience and it will enable them to make a decision;
- Display the data using appropriate graphs, tables, visuals, etc.;
- Check any written materials and visuals to ensure that you have used proper scientific convention ;
- Cite all of your references using the format selected by your teacher;
- Provide a model and/or drawing or photograph of your "improved" vehicle.