Name: Core:

Start Date: End Date:

**Engineering Design**

Title:

**DEFINING A PROBLEM:**Explain exactly what needs to be designed. Identify criteria as well as the constraints of the product.

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| **PWT** | **PNP** | **PRO** | **PHP** |
| Describes an engineering problem that is mostly complete.Describes personal experiences, previous solutions, and/or scientific concepts that may or may not relate to the problem or the design of a solution.Testing criteria and design constraints do not relate to solving the problem. | Describes the engineering problem, but doesn’t include a way to test it.Describes personal experiences, previous solutions, and scientific concepts to relate to the problem or the design of a solution, but need more detail.Testing criteria and design constraints are identified, but are superficial or do not directly relate to solving the problem. | Describes a testable engineering problem.Describes personal experiences, previous solutions, and scientific concepts related to the problem and the design of a solution.Testing criteria and design constraints are clearly identified and relate to solving the problem. | Clearly describes a scientifically testable engineering problem.Describes in detail personal experiences, previous solutions, and scientific concepts that relate to the problem and the design of a solution.Testing criteria and design constraints are clearly created and address a real- world problem as effectively as possible. Selection of criteria and constraints is explained. |

**Statement of the Problem:** Who? What? Where? When? How? Why?

**Background Information:** Write about the problem and describe the science, math and/or engineering concepts you will use to create a new solution. Include previous solutions such as products, processes or systems that have been used to solve the problem in the past, and reference the source(s) of your information.

***What You Already Know:***

1. Describe one or more personal experiences or stories where you've experienced this problem.

1. Use complete sentences to explain what you already know about the problem. Why is it a problem? Who does it affect?

1. Use complete sentences to explain what you already know about previous solutions to the problem. How have other people tried to solve this problem?

**What You Learned Through Research:**

1. Explain what you learned about the problem through research.

E. Explain what you learned about previous solutions to the problem through research.

Example of an existing Engineering Design

(Add additional pages as needed)

**References:** Use APA style.

Author, A. A., & Author, B. B. (Date of publication). Title of article. *Title of Online Periodical, volume number (issue* number if available). Retrieved from http://www.someaddress.com/full/url/ (Date of retrieval)

**Evaluation Criteria:** Define how you will rate the quality of your design.

**Constraints:** Define the limits for your project in terms of time, resources, material strength, sustainability, etc.

**DESIGNING A SOLUTION:**
*Explain how the solution is designed and describe how to make the prototype.*

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| **PWT** | **PNP** | **PRO** | **PHP** |
| Gives an incomplete description of an engineering solution. Incorrectly uses the concept of trade-offs to evaluate possible  solutions in terms of criteria and constraints.Presents solution for testing with unrelated criteria. | Describes only one possible engineering solution.Makes limited use of design and performance criteria, constraints, priorities, and trade-offs to evaluate the solution. Presents a solution for testing that partially relates to criteria and constraints. | Describes possible engineering solutions to the problem identified. Evaluates the proposed solutions in terms of design and performance  criteria, constraints, priorities, and trade-offs.Selects and explains why a proposed solution was selected for testing based on criteria and constraints. | Describes a variety of possible engineering solutions that are distinctly different. Uses the concept of trade-offs to compare and evaluate possible  solutions in terms of criteria, constraints and priorities.Selects and defends a solution for testing based on a comprehensive review of the design and performance criteria and constraints. |

**Explore different options to find the best solution:** Describe different options that you might use in your design.

**Choosing a Solution:** Use the charts below to decide on a solution.

* Does it fit the constraints?
* Will it solve the problem?
* Can I actually build it?

Design Idea #1

Design Idea #2

Design Idea #3

Strengths

Weaknesses

Strengths

Weaknesses

Strengths

Weaknesses

* Does it fit the constraints?
* Will it solve the problem?
* Can I actually build it?
* Does it fit the constraints?
* Will it solve the problem?
* Can I actually build it?

**Solution:** Describe the chosen solution. Explain why it was selected over the others and how it fits within the design criteria and constraints.

**Materials List:** List the tools and types of materials needed to make a prototype. Include the amount of each material needed.

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| **Tools** | **Materials** | **Where will I get this?** | **Amount** |
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**Procedures for Making Prototype:** Number and explain exactly how to build the prototype.

 (Add additional pages as needed)

**Initial Schematic:** Draw the prototype to scale and label each part. Include your scale. Use a straight edge and give measurements in metric units.



**TESTING SOLUTIONS AND COLLECTING DATA:***Collect, organize, and graph the data to show if the prototype meets the claim.*

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| **PWT** | **PNP** | **PRO** | **PHP** |
| Constructs a solution that does not address the criteria and constraints and cannot be tested.Collects data that is not relevant to the criteria and constraints and does not use appropriate techniques to test or analyze a solution.Displays data that is incorrect and does not facilitate evaluation of the solution.Displays data in an unorganized chart/table. Units are incomplete or incorrect.Graph is included but does not accurately reveal results of the investigation.Graphs and data tables include irrelevant titles. | Constructs a solution that does not adequately address the criteria and constraints and/or can only be partially tested.Collects data partially relevant to the criteria and constraints and/or uses partially appropriate techniques to test or analyze a solution.Displays data that is incomplete or does not facilitate evaluation of the solution.Displays data in an organized chart/table, but units may be incomplete or incorrect.Graph is included but range, intervals or location of variables may lead to misinterpretation.Graphs and data tables include incomplete titles. | Constructs a solution that adequately addresses the criteria and constraints and is appropriate for testing.Collects accurate data relevant to the criteria and constraints using appropriate techniques to test or analyze a solution.Displays data that is complete and facilitates evaluation of the solution.Correctly and accurately displays data labeled with appropriate units in an organized chart/table. Graph is included with appropriate range.Graphs and data tables include relevant titles. | Constructs a solution that thoroughly addresses the criteria and constraints and is appropriate for testing. Design may incorporate modifications made during construction.Collects relevant, accurate, and sufficient data relevant to the criteria and constraints using effective and/or advanced techniques to test or analyze  a solution.Displays data that is complete and facilitates a thorough evaluation of the solution.Correctly and accurately displays data labeled with appropriate units in an organized chart/table that facilitates analysis. Graph is included with appropriate range and intervals.Graphs and data tables include titles addressing the variables. |

**Evaluation Criteria:** How will you know if your prototype is successful?

**Dependent Variable:** What will you measure and which units will you use?

**Controlled Conditions:** List the variables that need to be kept the same to make it a fair test and make results more reliable.

**Testing Procedures:** Explain exactly how to test the prototype, identifying the steps used.

**Design and Redesign:** Build and test your first prototype. Use the boxes below to record qualitative and quantitative observations. Redesign your prototype to make it more successful.

**What worked well?**

**What didn’t work?**

**What will you change?**

Draw a sketch (and/or take a picture) of Prototype 1

Prototype 1

**Data Table for Prototype 1:** Label columns, rows, and give the units. Use a straight edge to draw your table. If measurements are not used, observations, a rating-scale, and/or pictures of before and after could be included.

**Data Table for Prototype 2:**

**What worked well?**

**What didn’t work?**

**What will you change?**

Draw a sketch (and/or take a picture) of Prototype 2

Prototype 2

**What worked well?**

**What didn’t work?**

**What will you change?**

Draw a sketch (and/or take a picture) of Prototype3

Prototype 3

**Data Table for Prototype 3:**

**Graph:** Choose the type of graph that best shows patterns or trends in your data. Give each graph a descriptive title and indicate units. You may use graph paper or a computer generated graph. Graph only the AVERAGES—do not graph all the trials. Be sure each axis has a label with the proper units and the graph has a title.



**ANALYZING AND INTERPRETING RESULTS**: *Use your data to explain the results of testing your prototype and explain what you would do to make it better next time.*

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| Does not use data to evaluate the design.Inaccurately or incompletely evaluates the tested solution in limited terms of design and performance criteria, constraints, priorities, and/or trade-offs.Provides little evidence regarding how the solution addressed the criteria and constraints.Identifies irrelevant design improvements. | Uses data to evaluate the design but it is slightly confusing. Partially evaluates the tested solution in terms of design and performance criteria, as well as constraints, and identifies some priorities and trade-offs.Incompletely describes to what extent the solution addressed the criteria and constraints.Identifies simplistic design improvements. | Uses data to evaluate the design. Evaluates the tested solution in terms of design and performance criteria, as well as constraints, and identifies some priorities and trade-offs.Describes to what extent the solution addressed the criteria and constraints.Identifies and explains possible design improvements. | Highlights patterns or trends in data and uses them to evaluate the design. Thoroughly evaluates the tested solution and testing process referencing design and performance criteria, constraints, priorities, and trade-offs.Thoroughly explains to what extent the solution addressed the criteria and constraints.Identifies and explains in detail possible design improvements using scientific and engineering principles and trends in the data collected. |

**Explain Patterns and Trends:** Write a short description of what your graph(s) show. Describe patterns in the data.

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**Results of Prototype Test:** Restate the evaluation criteria and use data to discuss whether or not the prototype was successful.

**Evaluation of Solution:** Describe the tradeoffs that had to be made in the process of designing, building, and testing the prototype.

**Improving the Design:** Be very specific about how your design could be improved. Use the results from testing your prototype and any scientific or engineering principles you have learned about to support your ideas.

Illustration of New Design Idea