

“The effect of the size of the rubber band and size of the propeller on the speed of the submersible”

This project was evaluated using the point scale of 0-1-2-3. The project was evaluated based on the visible information in the project photograph; some more information may have been on the additional sheets.

A. Title

Title: The effect of the size of the rubber band and size of the propeller on the speed of the submersible.

Score: 3 – *The title correctly states the independent variable and the dependent variable and is NOT worded as a QUESTION.*

Comments: This is a design experiment and therefore includes two independent variables. This title correctly states both the independent variable (size of the rubber band and size of the propeller) and the dependent variable (speed of the submersible).

B. Question

Question: How does the size of the rubber band affect the speed of the submersible?
How does the size of the propeller affect the speed of the submersible?

Score: 3 – *The question states the independent variable and the dependent variable, and is testable.*

Comments: Both questions correctly state the independent and dependent variable. In addition, the dependent variable is measurable.

C. Hypothesis

Hypothesis #1: If we change the thickness of the rubber band (1/16”, 3/32”, 1/8”) then the thickest rubber band (1/8”) will increase the speed of the submarine because it stores more potential energy to transfer to the propeller (Pitsco, 2013). The more potential energy imposed on the propeller from the thickest rubber band, the higher the kinetic energy produced by the propeller thus increasing the speed of the submersible boat (Robertson, 2002).

Hypothesis #2: If we change the size of the propeller (large or small) then the small propeller will increase the speed of the submersible, because increasing the size for the propeller increases drag. For forward movement to take place, thrust must be equal to or greater than the drag. If, for any reason, the amount of drag becomes larger than the amount of thrust, the object will slow down (Brian, Adkins, & Lamb).

Score: 3 – *The hypothesis (1) predicts the effect that changing the independent variable will have on the dependent variable, AND (2) explains the reason for the prediction using scientific concepts (“because…”).*

Comments: Both hypotheses predict which independent variable the students think will cause the submersible to have the greatest speed. In addition, the students chose accurate scientific concepts in order to support their hypotheses. They also cite their scientific information.

D. Background Research (found throughout the project especially within the hypothesis and discussion/conclusion sections)

Score: 3 – *Background research is accurate, containing MANY relevant, well-chosen facts, definitions, concrete details, quotations, scientific concepts, or other information and examples that (1) provide information on the IV & DV; defining them and explaining the relationship between them AND (2) supports the “because” portion of the hypothesis AND(3) attempts to support the “scientific reasoning” of the discussion/conclusion.*

Comments: The background information section is very detailed and includes many relevant facts.

E. Investigation Design (ID)

Score: 2 – Four of the 5 components of the ID are stated correctly, OR more than one IV is changing at a time or there are not multiple trials.

Comments: The ID seems to be missing some information. The 5 components of the ID are independent variable, dependent variable, levels of IV, number of trials, and constants. The ID as it appears only has the IV & DV. However, it appears in the photo that there is a piece of paper covering the bottom of the ID where we can assume the rest of the information appears. The students state the number of trials in the data collection table. The levels of IV are stated in the hypothesis, procedure & data collection table. However, the constants do not appear specified in any portion of the project.

F. Procedure

Score: 1 – The Procedure accurately and completely satisfies one of the above. (The procedure is (1) a step-by-step description of how the investigation was done AND (2) uses precise language and scientific vocabulary to describe both the sequence of actions taken and materials used AND (3) is sufficiently detailed to enable the reader to replicate the investigation AND (4) is consistent with the Investigation Design Diagram (IDD) and is an appropriate test of the hypothesis.)

Comments: The procedure only describes how to create a submersible. In order to score a 3, the students must specify how to conduct the experiment to test the independent variables. It looks as if there may have been additional pages underneath the top page on the project board, however we can only grade what is seen.

G. Data/Results

Score: 3 – Data table(s) and graph(s) (1) are accurate and include labels (titles, axes with units of measure AND (2) address the hypothesis and have been chosen to clearly address the original question AND (3) data analysis identifies and accurately summarizes trends and patterns in the data.

Comments: The students show a great use of the UA graphic organizers. There are appropriate data tables and graphs for both independent variables, as well as accurate data analysis for each graph.

Ha. Discussion/Conclusion: Scientific Explanation

Score: 3 – A scientific explanation consisting of a statement that 1) makes an overall claim addressing the original investigation question AND 2) supports the claim with evidence and relevant, accurate data from the investigation AND 3) contains relevant scientific concepts AND 4) uses words, phrases and clauses that clarify and connect the relationships between claim, evidence and science concepts AND 5) demonstrates an understanding of the topic.

Comments: Both explanations are supported by evidence, data, and include in text citations. Since this is a design experiment, the students also included a “Best Design” section, hypothesizing which two levels of independent variable would cause the submersible to have the greatest speed. They ran three additional trials using these IVs and completed data analysis on the Best Design.

Hb. Discussion/Conclusion: Reflection

Score: 3 – Conclusion contains thoughtful, relevant, and reasonable reflections including: 1) states whether the hypothesis was or was not supported AND 2) a description of possible sources of error AND 3) suggested solutions to these sources of error AND “Next Steps” determined as a result of this investigation.

Comments: The students state sources of error and that their hypothesis was supported.

I. Literature Cited

Score: 3 – A sufficient number of credible sources (1) are listed in the bibliography in an appropriate format that allows the reader to locate the resource AND (2) are cited in the text of the hypothesis, background research, conclusion, and other sections as appropriate AND (3) include books, articles, scholarly websites, or personal communication with knowledgeable experts/scientists.

Comments: The students correctly formatted their Literature Cited section, had appropriate resources, and cited sources throughout the project.

Project Section	Score (0-3)	Weight	Weighted Score
A. Title	3	x 1	= 3
B. Question	3	x 1	= 3
C. Hypothesis	3	x 2	= 6
D. Background Research	3	x 2	= 6
E. Investigation Design (ID)	2	x 2	= 4
F. Procedure	1	x 2	= 2
G. Data/Results	3	x 3	= 9
Ha. Discussion/Conclusion: Scientific Explanation	3	x 2	= 6
Hb. Discussion/Conclusion: Reflections	3	x 1	= 3
I. Literature Cited	3	x 2	= 6
		Total weighted score	= 48 (54 max)
	Final Score (%) =	=Total weighted score/54 x 100	= 89%