

PHYSICS – Sample E arrow penetration

TOTAL MARKS (out of 24) FOR THIS INVESTIGATION = 13

PERSONAL ENGAGEMENT: Best-fit Mark = 1

Evidence of personal engagement: There is nothing obvious other than the design of the investigation and the basic idea of the IA. Both seem appropriate but we are reading between the lines here. Descriptor level 1 may be applicable. (Markband 1)

Justification given for research question: There is no justification and no detailed scientific explanation given here. Much more is needed than an off-the-cuff comment about an inversely proportional relationship. The student must have had some experience with archery and some knowledge of high school physics. (Markband 0)

Evidence of personal input and initiative in designing, implantation or presentation: The design is straight forward, so reading between the lines we can give this markband 1. The penetration depth color technique is about all that we can identify here, little other evidence of personal input. (Markband 1)

EXPLORATION: Best-fit Mark = 3

Topic of investigation identified, research question described: The research question is straightforward and worthy of an IA. It is not fully described, however, as control over the angle of the initial arrow and the extension of the bow (initial energy input) for each arrow are not mentioned. This fault comes under methodology, however. You cannot shoot an arrow and hit the same target from different distances without changing the initial angle. If this is too small an angle for the given investigation then the student should have explained this. Also, how does the projectile path compare to the horizontal distance in the RQ? Much more needs attention, but this comes under the 'methodology' descriptor. The RQ is sound. (Markband 6)

Background information: There is no attempt other than an incorrect hypothesis about the possible conclusion of the experiment. There is plenty of room for thought here: elastic and kinetic energy, projectile motion, impact speed and energy dissipation, etc. and other high school physics background. (Markband 0)

Appropriate methodology, consideration of reliability and sufficiency of data: This Descriptor is addressed somewhat appropriately with the exception of the two controlled variables mentioned in the first Descriptor above; the omitted angle and the initial bow extension are too crucial to award this a 5 or 6. And what about the impact angle? The controlled variables must be addressed. Non-metric units is confusing. (Markband 2)

Evidence of significant safety or environmental issues: Design Aspect 3 in the report indicated safety issues. There should have been other issues, too, like people in the near environment of the target. (Markband 1)

ANALYSIS: Best-fit Mark = 3

Sufficient raw data for a valid conclusion: The range is reasonable and repeated trials are appropriate. But why not use SI units? How could the student measure penetration depth to a thousandth of an inch? The raw data table gives no units for penetration but we know what they are. (Markband 3)

Data processing, accuracy and consistent: Processing was done correctly but there was an inconsistent use of significant figures. (Markband 5)

Impact of uncertainties on the analysis: No uncertainties for the range were given. Uncertainties for averages were done correctly but the three decimal places for the averages and uncertainties are not acceptable. (Markband 3)

Interpretation of processed data: The two graphs are relevant but how these will be interpreted is not yet clear. More analysis is needed before a conclusion can be stated. Indeed, the shape of the graph is rather perplexing. Did the arrow go through the target? Is a 15 to 18 inch penetration normal? (Markband 3)

EVALUATION: Best-fit Mark = 2

Conclusion statement, detailed, justified and supported by data: The student correctly reads the graph and decided their hypothesis is wrong. This is merely a qualitative statement, not a scientific or mathematical one. The shape of the graph has not been determined nor has the unusual meaning of the results been appreciated. (Markband 3)

Conclusion and accepted theory, described and justified: There is nothing here. (Markband 0)

Strengths and weaknesses, limitations of data and method: The student is aware of a few of the relevant issues, but very basic. What about the extension of the bow? (Markband 2)

Realistic and relevant improvements and extensions: There is nothing here directly relevant to the student's work other than the penetration area and resistance of the target. There are no extensions. This could be markband zero but with some BOD it earns markband 1. (Markband 1)

COMMUNICATION: Best-fit Mark = 4

Presentation of investigation and errors affecting understanding, focus and outcome: The presentation is straightforward. (Markband 4)

Report structure, focused and coherent: The structure is focused and clear, and the report flows well. Each step makes sense. (Markband 4)

Report relevance, concise, focus on outcome: Indeed, the outcome (no theory, but data) was always concise and relevant. (Markband 4)

Terminology, subject specific: The inconsistent significant figures, precision beyond reason, and using yards and inches were the only distractors. Nonetheless, yards and inches work for this investigation. (Markband 3)