



Ping-Pong Ball Launcher

A Freshman Engineering Design Project
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Overview:

The project entails designing, analyzing, constructing and reporting on a launcher which will propel a Ping-Pong ball, *in flight*, for any distance from as little as one foot to a maximum of thirty five feet and have the Ping-Pong ball impact a target point with the highest degree of accuracy. Each team will be responsible for preparing a project proposal, developing the design itself, and writing a final report. This team project is the “*Integrated Project*” portion of the students’ final grade in Chemistry, Engineering, English, Math and Physics.

Learning Objectives or Student Outcomes:

By the end of this project, students will be able to work as a team to

1. complete and orally present a proposal for a Ping-Pong ball launcher which will propel a Ping-Pong ball, *in flight*, for any distance from as little as one foot to a maximum of thirty five feet and have the Ping-Pong ball impact a target point with the highest degree of accuracy;
2. analyze and construct the designed launcher;
3. demonstrate the completed design; and
4. complete and submit a final written report on the design process.

Length of Lesson:

This project is generally one of two or three in a semester. The length of the lesson will vary depending on a few factors: the amount of in-class time allotted to the project; the amount of out-of-class time deemed necessary by the instructor; and any other activities which are taking place during the duration of the project.

Assignment(s) to Ensure Student Preparation:

Although there are no specific assignments to ensure student preparation, this project is the “*Integrated Project*” portion of the students’ final grade in Chemistry, Engineering, English, Mathematics and Physics; knowledge obtained in these concurrent courses will therefore contribute to the project.

Team Size/Composition:

Teams of 4 work best; if necessary, a few teams of 3 or 5 students may be formed.

How is *positive interdependence* ensured?

Each team works together to complete and present one project proposal, to analyze and construct one launcher, and to write one final report.

How is individual accountability ensured?

The first point at which individual accountability is ensured is during the proposal presentation. Questions may be addressed toward the entire team or to one individual only. Each member of the team must be familiar with every aspect of the proposal. At the conclusion of the project, peer assessments may be done to further ensure individual accountability.

Components of Assessment:

Students will be provided with extensive proposal and report guidelines. Students must successfully present their proposal to the faculty team in both written and oral form before they are given permission to begin construction on their designs. Final assessment will be based on the finished design product, the demonstration of that product, and the written report.

Team Skills Needed for Success:

All team members must have the ability to communicate, cooperate and collaborate; they must also feel free to share their own ideas and to give and receive constructive feedback.

How Are These Skills Emphasized?

These skills are emphasized by the entire project, but perhaps by the oral presentation of the proposal more than anything else, where they need to work together to ensure complete preparation of all individuals.

Materials Needed by Students:

- Materials chosen for project design
- PowerPoint software
- Computer

Multimedia Needs for Instructor:

- PowerPoint presentation system for proposal presentations

Instructions to Students:

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Project Overview

The project entails designing, analyzing, constructing and reporting on a launcher which will propel a Ping-Pong ball, *in flight*, for any distance from as little as one foot to a maximum of thirty five feet and have the Ping-Pong ball impact a target point with the highest degree of accuracy. For the purpose of this project, accuracy, A , is defined by the following relationship:

$$A = \frac{(D_t - [D_r + D_p])}{D_t} 100.0\%$$

where D_t is the distance between the launcher release point and the target, D_r , is the radial deviation from the target to the point of impact, and D_p is the

	<p>perpendicular deviation from the straight line formed between the launcher and the target to the impact point.</p> <p>Each team will be responsible for preparing a project proposal, developing the design itself, and writing a final report. This team project is the “<i>Integrated Project</i>” portion of your final grade in Chemistry, Engineering, English, Math and Physics. The proposal and report will be discussed in detail in your English class, but, in each case, the proposal and report will be evaluated by the faculty team for both its technical merit and its style correctness (i.e. report form, spelling, grammar, and the like). <i>Please be aware that your ability to perform the appropriate analysis in both the proposal and the final report will constitute a significant portion of your project grade.</i></p>
<p>2</p>	<p>Evaluation Overview</p> <p>The criteria for evaluating your project will be</p> <ol style="list-style-type: none"> 1. your written and oral proposal; 2. a demonstration of the functionality of your design via an accuracy measurement; and 3. your final report. <p>Your creativity will also be given consideration.</p> <p>Remember: This team project is the “<i>Integrated Project</i>” portion of your final grade in Chemistry, Engineering, English, Math and Physics. Take it seriously and get started early.</p>
<p>3</p>	<p>The Proposal</p> <p>Prior to beginning work on your projects, your team will be completing both a written and an oral project proposal for the faculty team. <i>Your team may not begin construction of its design until the proposal has been presented and fully accepted!</i></p> <p>As part of your proposal/report you MUST include: 1) measurements of horizontal range as a function of any variable launcher parameter(s), as well as a discussion of error analysis; 2) a comparison of experimental data to theoretical predictions; and 3) an estimation of the drag force acting on the Ping-Pong ball based upon <i>your</i> measured data.</p> <p>You will also be required to submit a budget as part of your proposal/report that will include, in part, your estimate for materials to fabricate your design. (You should assume that the nominal budget for materials will not exceed \$20.03.) Of course, as with any proposal, your plan may be rejected if the estimated project cost is inconsistent with the estimated project returns. In addition, the final project grade will take into account the accuracy of your cost estimate, as well as the cost effectiveness of your design.</p> <p>For more information on the proposal, see Proposal Requirements and Guidelines.</p>

4	The Demonstration The demonstration will include, but is not limited to, measuring the accuracy of your launcher at three different target distances when the Ping-Pong ball is launched from an indoor location.
5	The Written Report Your final project report may include portions of your written proposal, updated to be current in terms of verb tense and data. In addition to providing a final design description and budget, your report must include a complete analysis: <ul style="list-style-type: none">• performance measurements from the design competition,• a comparison of expected and actual results,• a discussion of factors influencing performance outcomes and (if necessary) suggestions for possible changes, and• an instruction sheet on how to operate your launcher (an appendix to the report).

Handouts:

- [Proposal Requirements and Guidelines](#)

Proposal Requirements and Guidelines

Proposal Content:

The proposal (both in oral and written versions) must include the following:

- a well-worded, clear, and efficient problem/objectives statement.
- a thorough technical approach description, including
 - a complete prototype design description (including well-integrated drawings);
 - a technical analysis describing the Ping-Pong ball distance, velocity, and acceleration predictions, as well as the forces required to produce said motion;
 - an estimation of the drag force acting on a Ping-Pong ball for your launcher design; and
 - an analysis of your design plans, including discussion of any potential problem areas.
- a team management plan, including
 - a detailed project timeline (from the beginning of the project construction through the submission of the final report); and
 - a realistic division of tasks.
- a clearly researched and specifically itemized budget, or cost, section, including itemized construction costs for the prototype (less than or equal to \$20.03).
- any safety considerations, including but not limited to: launcher operation; Ping-Pong ball velocity; or any other factor which you believe to be a potential hazard.

Proposal Format

The proposal presentations will be given during the engineering class. The preferred medium for this presentation is PowerPoint®. At the time of the presentation, you must provide two (2) hard copies of the proposal as well as a hard copy of your PowerPoint® presentation in the proposal appendix. At the end of the presentation, you must also submit your diskette, or the location of your file on the local area network.

Oral Presentations of Proposals

Teams will be assigned 20 minute time slots. The time slots will be assigned randomly with the final order being announced the call day prior to the presentations. If your team has a conflict with your assigned time, you must inform the faculty teaching team, via email, in a timely manner.

You will be allowed 5 minutes to set up and 10 minutes to present your proposal. During your presentation, only your team and the people evaluating the proposal (the faculty team) will be present. You must be prepared to answer questions about your proposal. These questions

may be addressed to the team in general or to a specific person (i.e. “Mr. Smith, could you explain how...”); thus, each member of your team must be conversant with all aspects of the proposal. Five minutes will be allotted to the question/answer period.

Important Proposal Reminder: Remember that these proposals must be complete, detailed, and persuasive. Of course, as with any proposal, your plan may be rejected if it is too vague and/or if the estimated project cost is inconsistent with the estimated project terms. The results of your proposal may range from full acceptance to complete rejection. If your proposal is rejected, in part or in whole, you will be required to update it and submit, in written form, the amended proposal within 1 week of notification. Once your proposal is fully accepted, you may begin construction of your model.