**SPH4U – Culminating task: Arcade game**

**Objective:** To design and Build an arcade-style game based on the physics principles learned in the physics 12 course. Ideally the machine launches a marble using elastic potential energy and uses most of the principles listed below throughout the game:

* Elastic force / Elastic potential energy
* Projectile motion
* Forces (including friction, ramps )
* Circular motion (optional)
* Transformation of energy between kinetic and gravitational potential energies
* Impulse-momentum and collision principles

You will be working in teams of 4 people collaboratively. Each student both works on a module (a specific mechanism of the product and its calculations) independently, and also contributes to the design process and interfaces as part of the team.

**Project Requirements:**

1. **Group component:**

**Each group will digitally submit to D2L: (Provide a printed document as well)**

1. A written proposal including: game name, rules or objective of the game, preliminary design, technical specifications, cost estimate, physics principles covered, an estimate on workload distribution and time allotment for each member. (Due date announced in class)
2. Final Report: (font: 11 Calibri font, double spaced)
3. A portfolio (Engineering design notebook, see template) that includes attendance, agenda and minutes of all in-person meetings. The template being used for each meeting needs to indicate each individual input, intermediate modification to the design process, and may include pictures or drawings of prototypes and/ or drawings. The agenda and date of the next meeting needs to be reflected on this sheet as well.
4. A neat and labelled scale drawing of the design of the machine including dimensions in cm, on a 11”x17” paper. Include both top view and side view if necessary.
5. A document that includes design rationale, specifications, mechanisms used, concepts and materials used, and the rules of the game to the potential end user. Potential problems and limitations must also be included in this document.
6. A working prototype of the machine
7. **Individual component:**

**Each student will individually submit:**

1. A neat and labelled scaled drawing of each mechanism worked by individual student. (e.g. launch mechanism.)
2. A sample problem and solution for the mechanism worked by the individual student ( e.g. Show calculations for the spring constant and stretch of the spring required to launch the ball to the sufficient length on a board to hit a target)
3. Identify the mechanisms used in your machine ( i.e. elastic force of a spring has been used for the ball release mechanism, how it launches the marble,…)

**Design and build Criteria for the machine**

* No larger than 100 cm x 100 cm x 100 cm.
* Frame made from wood, cardboard, plastic, or other recyclables,… (the focus must be on usage of “junk” and cheap material to keep the cost down.
* A ball launcher that uses elastic potential energy
* A variety of paths for the marble (may include loops, multi levels,…) that makes the game interesting.

**Sample Specification table**

|  |  |
| --- | --- |
| Board dimensions (L x W x H) |  |
| Angle of inclination |  |
| Mass of the marble |  |
| Elastic band/spring constant |  |
| Length of the ramp |  |
| Mass of the final product |  |

**The Engineering Design Process and Engineering Notebook:** The engineering design process is a series of steps that engineers follow to come up with a solution to a problem. Many times the solution involves designing a product (like a machine or computer code) that meets certain criteria and/or accomplishes a certain task.

* The steps of the engineering design process are to:
  + Define the Problem
  + Do Background Research
  + Specify Requirements
  + Brainstorm Solutions
  + Choose the Best Solution
  + Do Development Work
  + Build a Prototype
  + Test and Redesign

Engineers do not always follow the engineering design process steps in order, one after another. It is very common to design something, test it, find a problem, and then go back to an earlier step to make a modification or change to your design. This way of working is called **iteration**, and it is likely that your process will do the same!

An **Engineering Notebook** is a record of the design process; it is basically a “diary” that designers keep as they progress through the process.  Engineering Notebooks come in many different formats, but they should detail each step of the process. They should combine a narrative of the progress, concept sketches, engineering calculations, pictures of prototypes, test procedures, and more.  Some of the most important things to record are the decisions made, and the reasoning behind these decisions.  Later on in the design process, if a designer runs into a problem and does not remember why something was done a certain way, the notebook will provide a good reference.  A Design Notebook should serve as a roadmap such that any outsider can follow the designer’s process; understand the choices made by the designer, and end up with the same result. Every notebook entry should be dated and signed by the designer to provide proof of when the documented work was done; this comes in handy during any patent or intellectual property debates that occur over the design.

**Please visit the following website to organize your design process:** <http://www.sciencebuddies.org/engineering-design-process/engineering-design-process-steps.shtml#theengineeringdesignprocess>

**Other resources:**

<http://curriculum.vexrobotics.com/curriculum/intro-to-engineering/design-documentation>

<http://www.sciencebuddies.org/engineering-design-process/engineering-design-process-steps.shtml>

Marble machine: <https://www.youtube.com/watch?v=OsaXYl8YL4Q>

Swing toy: <https://www.youtube.com/watch?v=72xzHebbawk>

**Arcade game: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Meeting # \_\_\_\_\_\_Date: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

Group members attending: name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, Signature: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, Signature: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, Signature: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, Signature: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Meeting duration: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Meeting place: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Agenda:**

**Progress (include input by individuals, modifications and reason for changes,…)**

**Follow up topics (planning further steps):**