

# AP Physics Project

## Rube Goldberg Machine

---

This AP Physics project is to design a Rube Goldberg Machine (RGM). An RGM, named after the Jewish-American engineer-cartoonist Reuben Goldberg, is a:

“...comically involved, complicated invention, laboriously contrived to perform a simple operation...”

– Webster's New World Dictionary.

RGMs are not so far-fetched...you drive one to school everyday...

This project will allow you to demonstrate your knowledge of the physics models you have learned thus far in class as you design an RGM. The project will be divided into two phases. Phase I is the design phase and will be due in February and will be completed individually. Phase II is the construction phase and will be due after the AP Exam **AND IS OPTIONAL (more details on why you would do this is described in the Phase II section below)**. Phase II can be completed individually or in groups of two MAX.

### Phase I – Design

The goals of Phase I are to:

- create a Google Sketchup 3D drawing of your RGM that demonstrates each of the four linear Physics models studied this semester (Kinematics, Force, Energy, and Momentum). You can download Google Sketchup for free. Google has a series of training videos on how to create 3D models. Check them out!
- author and solve a multi-part “AP-style” problem that addresses each of the four linear Physics models in your RGM and,
- write a Phase I debrief.

### *Google Sketchup Drawing*

Your RGM should have a purpose that it will consistently perform each time the RGM is started. Examples of PARTS of possible RGMs include: shooting a toy monkey with a crossbow, lifting a mass a certain height, moving a block or other object across a rough surface a certain distance, launching a paper airplane, playing a song, etc. Each step should be mechanical (as opposed to chemical or electrical) in nature. Be creative as possible keeping into consideration that might eventually build your RGM. See the Rube Goldberg videos on LewTube for ideas. A “step” is defined as one mechanical motion that is directly related to one of the Kinematics, Force, Energy, or Momentum models. Each design will include AT LEAST four steps, one per model, although you may include more in your design. If working in groups of TWO, each student must still include four steps addressing the four models for a total of at least EIGHT steps.

### *AP Style Problem*

In addition to the design of your RGM, you will author and solve a multi-part “AP-style” problem that incorporates the four LINEAR Physics models that you have studied this semester (Kinematics, Force, Energy, and Momentum). You DO NOT have to create “AP-style” problems for the rotating parts in your RGM. The problem statement will include at least two questions for each part of each model (i.e. 2 parts for the Kinematics model, 2 parts for the Force model, etc.) for a total of at least 8 parts.

Your solution for each part will consist of HW style, non-cowboy solution method.

### *Project Debrief Questions*

The last part of the written report will be a project debrief addressing the following:

- i. The “fun/interesting” level of the design phase of the project on a scale of 1-10 with reasoning for your answer.
- ii. The “difficulty” level of the design phase of the project on a scale of 1-10 with reasoning for your answer.
- iii. Two concrete physics concepts that you learned or concepts that were solidified for you in the design phase of this project.
- iv. At least one concrete physics concept/physics model that is still unclear to you.
- v. What you thought of the design phase of the RGM project as a whole.

**INCLUDE A COVER SHEET USING THE SAME FORMAT THAT YOU HAVE USED FOR PREVIOUS LABS.**

\*\*\*\*\*

## Phase II – Construction (OPTIONAL)

This phase will require you to build and demonstrate your RGM! Demonstrations will take place after the AP Exam. Successful construction and demonstration of your RGM will earn you TWO extra test grades that will be averaged in with your other test grades. Note that these extra test grades will augment your “Test Grade” category and will help you attain your contract grade that will exempt you from the final exam!

### Point Distribution

1. RGM Construction 40 points

RGM meets construction/innovative criteria below

2. RGM Functionality 30 or 40 points

Partially Functions 30 points (half of declared steps work as planned)

RGM Fully Functions 40 points (all steps work as planned)

You are allotted THREE official trials to demonstrate that your RGM works as planned.

3. Google Sketchup II 10 points

Updated Google Sketchup including rotational models

4. Debrief II: 10 points

### Safety

You should purchase a pair of goggles before you construct and operate your device. There will be a goggle check day where you will show your PERSONAL PAIR of goggles. SAFETY IS OF THE UTMOST IMPORTANCE IN THIS PROJECT!!

### Updated Design

An updated Google SketchUp diagram (with any changes/modifications from original design) will be turned in on your presentation day. If working in groups of two, a complete diagram showing all of the integrated steps will be presented.

### Design

Your RGM needs to include a **minimum** of eight steps from start to finish and each step must convert from one type of energy to another. Each of the four linear **AND** rotational Physics models should be demonstrated in your RGM.

For safety reasons, you may not use flames or chemicals (basic household food items are OK), other hazardous materials, or live animals. With the exception of an electrical motor (electrical energy), all steps should be mechanical in nature. In short, your RGM should be safe to use and there should be zero chance of losing appendages during the construction or operation of your RGM.

## **Construction**

Your RGM should be constructed from household materials. You may use spare toy parts (e.g. Lego, K'nex, etc), but these should account for no more than 50% of your building materials. The total cost for your machine should not exceed \$25.00 based on the 2004 price of plywood at Home Dept at an annual inflation rate of 2.56%. You should plan to put the pieces together with nails, screws, brackets, wood glue, hot glue, or other things found in your house, garage, or RGM toolkit. Your RGM will earn points for being innovative. Innovative is defined as using items that meet the non-intended use clause (e.g. using a roll of tape as a wheel, using a rubber band to accelerate an object, or using a thread spool as a gear, etc.) The final product should be sturdy and transportable and professional looking. Your RGM should have a name or theme. The maximum dimensions should be approximately 0.75 m x 0.75 m x 0.75. m. Please clear any deviations from these dimensions with Mr. Lew.

## **Reliability**

Your RGM needs to be reliable. Specifically, once you start the first step, the remaining steps should follow without any human intervention. In addition, you should be able to reset the machine quickly (within 3 min) for another run.

## **AP-Style Problem**

An updated AP-style problem including BOTH your linear AND rotational models will be turned in on your presentation day.

## **Project Debrief**

A second project debrief will be turned in on your presentation day.

### *Project Debrief Questions*

The last part of the written report will be a project debrief addressing the following:

- i. The "fun" level of the construction phase of the project on a scale of 1-10 with reasoning for your answer.
- ii. The "difficulty" level of the construction phase of the project on a scale of 1-10 with reasoning for your answer.
- iii. Two concrete physics concepts that you learned or concepts that were solidified for you in the construction phase.
- iv. What you thought of the construction phase of the RGM project as a whole.
- v. RGM project ideas that would increase the "fun" level and help your understanding of the "linear" and "rotational Physics models.