The Rube Goldberg Machine Competition: A joint project with Honors Pre-Calculus and AP Physics

**The Big Question**: How can we promote the Magnet Program at PCHS with a video that will incorporate math, science, engineering, and the arts?

**The Project**:

**Fall Semester**: Teams consisting of two students from honors pre-calculus and two students from AP Physics will compete to design a Rube Goldberg Machine to unfurl a banner promoting the Academy of Science, Research, and Medicine at Paulding County High School. The machine will be timed to a song or piece of music. Designs will be judged on feasibility, task completion, most challenging transfers of energy, artistry, creativity, cost, and the "Goldberg spirit" of humor.

**Spring Semester**: Four winning designs will be selected. Students from teams with designs not selected will be assigned to one of the winning teams. These four teams will be challenged to build their Rube Goldberg Machine and make a video of the machine in action.

**AP Physics Learning Objectives Addressed:**

4.A.2.1: The student is able to make predictions about the motion of a system based on the fact that acceleration is equal to the change in velocity per unit time, and velocity is equal to the change in position per unit time.

1.C.1.1: The student is able to design an experiment for collecting data to determine the relationship between the net force exerted on an object its inertial mass and its acceleration.

3.A.3.1: The student is able to analyze a scenario and make claims (develop arguments, justify assertions) about the forces exerted on an object by other objects for different types of forces or components of forces.

4.C.1.1: The student is able to calculate the total energy of a system and justify the mathematical routines used in the calculation of component types of energy within the system whose sum is the total energy.

5.D.1.4: The student is able to design an experimental test of an application of the principle of the conservation of linear momentum, predict an outcome of the experiment using the principle, analyze data generated by that experiment whose uncertainties are expressed numerically, and evaluate the match between the prediction and the outcome.

**Honors Pre-Calculus Standards Addressed:**

**MGSE9-12.F.TF.5** Choose trigonometric functions to model periodic phenomena with specified amplitude, frequency, and midline.

**MGSE9-12.N.VM.1** Recognize vector quantities as having both magnitude and direction. Represent vector quantities by directed line segments and use appropriate symbols for vectors and their magnitudes (e.g., **v, |v|, ||v||,** *v*).

**MGSE9**‐**12.F.TF.7** Use inverse functions to solve trigonometric equations that arise in modeling contexts; evaluate the solutions using technology and interpret them in terms of the context.

**MGSE9-12.N.VM.2** Find the components of a vector by subtracting the coordinates of an initial point from the coordinates of a terminal point.

**MGSE9-12.N.VM.3** Solve problems involving velocity and other quantities that can be represented by vectors.

**MGSE9-12.G.SRT.11** Understand and apply the Law of Sines and the Law of Cosines to find unknown measurements in right and non-right triangles (e.g., surveying problems, resultant forces).

**MGSE9**‐**12.G.SRT.8** Use trigonometric ratios and the Pythagorean Theorem to solve right triangles in applied problems.

STANDARDS FOR MATHEMATICAL PRACTICE

1. Make sense of problems and persevere in solving them.

2. Reason abstractly and quantitatively.

3. Construct viable arguments and critique the reasoning of others.

4. Model with mathematics.

5. Use appropriate tools strategically.

6. Attend to precision.

7. Look for and make use of structure.

8. Look for and express regularity in repeated reasoning.

**The Rube Goldberg Machine Competition: Fall 2021**

Your team will design a Rube Goldberg Machine to unfurl a banner promoting the Academy of Science, Research, and Medicine at Paulding County High School. The machine must be timed to a song or piece of music. Your machine must consist of at least 10 stages and run for a minimum of 2 minutes. Designs will be judged on feasibility, task completion, most challenging transfers of energy, artistry, safety, creativity, accuracy of calculations, and the "Goldberg spirit" of humor.

Your submission must include the following:

* A written description of your machine. Your description should include the location on campus where your machine will be set up, details of each stage, the time to complete each stage, the song your machine is timed to, details of how your machine is timed to the song, and the total time to complete the task.
* A scale drawing of the banner your machine will unfurl.
* A scale top view drawing of your machine.
* Scale drawings of each individual stage.
* Calculations showing the time to complete each stage.
* Calculation showing the energy transfer from each stage to the next.
* A cost estimate for your machine including a list of materials, estimated cost for each item, and the total cost.
* Optional (but recommended): A 3D drawing of your machine.