Name: Date:

Engineering Challenge: Rube Goldberg Machine

Standards:

MS-PS2-1: Use Newton's Third Law to design a solution to a problem involving the motion of two colliding objects.

MS-ETS1-1: Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.

Engineering Task:

Using your knowledge of force pairs and Newton's Third Law of motion, you will work in teams of 3 to design and build a Rube Goldberg Machine to complete a simple task. Your first step is to decide what task you would like your Rube Goldberg Machine to complete. Remember, the task must be simple, and must be approved by the teacher. Your machine **must involve at least 4 different collisions, which cause changes to the motion of object(s).** Your machine must take AT LEAST 6 seconds to complete the task. You will have 3 days to build your machine with whatever materials are available to you in class. Additional materials may be incorporated with teacher approval.

In the design and building of your machine, you must consider how Newton's 3rd Law influences the motion of the machine and helps your machine to accomplish the task. After your device is designed, built, and tested, you will **reflect on and analyze the forces acting on each object involved in each collision-** and explain how these forces caused the changes in motion observed in your device.

Brainstorm

Part 1: As an engineering team, decide what you want your machine to accomplish. Remember this is a simple task that is feasible (definitely possible or something you can easily do).

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<u>Part 2:</u> Materials- Use this page to keep a running list of the materials used in your machine. If additional materials are used, add them to your list. If materials are tested and no longer needed, put a neat line through the material to indicate it is no longer being included in your machine.

Part 3: Brainstorm each section of your machine. Draw diagrams for each section, then explain materials the section includes, and how it should function. Use Newton's Third Law to justify your choices. Remember, your machine must include a minimum of 4 COLLISIONS between two objects, which result in a change in an object's motion.

Diagram	Explanation

Diagram	Explanation

Final Diagrams

Part 1: Draw detailed diagrams for each section of your machine AFTER it is built and tested. Explain how each section functions, using Newton's Third Law to justify your choices.

Diagram	Explanation

Diagram	Explanation

Part 2: Below, draw your entire machine, as it looks when all sections are built and put together. For each section of the machine, explain what is happening.

Part 3: Force Diagrams and Analysis

Directions: For each section of your machine that involves a COLLISION, draw a force diagram for both objects involved in the collision. Then, use Newton's Third Law to answer analysis questions.

Word Bank

Action Reaction Force Magnitude Direction Acceleration

Collision 1:

Object 1: **(Action Force)**	**Object 2:** **(Reaction Force)**

1. Describe the forces being applied to each object during the collision, and how the object(s)'s motion changed in the collision.

Collision 2:

Object 1: **(Action Force)**	**Object 2:** **(Reaction Force)**

1. Describe the forces being applied to each object during the collision, and how the object(s)'s motion changed in the collision.

Collision 3:

Object 1: **(Action Force)**	**Object 2:** **(Reaction Force)**

1. Describe the forces being applied to each object during the collision, and how the object(s)'s motion changed in the collision.

Collision 4:

Object 1: **(Action Force)**	**Object 2:** **(Reaction Force)**

1. Describe the forces being applied to each object during the collision, and how the object(s)'s motion changed in the collision.

Collision 5:

Object 1: **(Action Force)**	**Object 2:** **(Reaction Force)**

2. Describe the forces being applied to each object during the collision, and how the object(s)'s motion changed in the collision.

Collision 6:

Object 1: **(Action Force)**	**Object 2:** **(Reaction Force)**

1. Describe the forces being applied to each object during the collision, and how the object(s)'s motion changed in the collision.

Newton's Third Law Rube Goldberg Machine Rubric

	Exceeding (4)	Proficient (3)	Approaching (2)	Developing (1)
Machine Components	Machine includes 6 components (sections), which involve the collision of two distinct objects, with at least 1 object experiencing a change in motion.	Machine includes at least 4 components (sections), which involve the collision of two distinct objects, with at least 1 object experiencing a change in motion.	Machine includes at least 4 components, but 1 component does not involve a collision or collision does not result in an object changing its motion.	Machine includes at least 4 components, but more than 1 component does not involve a collision or collision does not result in an object changing its motion.
Time of Task Completion	Machine takes 11 or more seconds to complete the task with no breaks or pauses	Machine takes 6-10 seconds to complete the task with no breaks or pauses	Machine takes less than 6 seconds, but without any breaks or pauses	Machine takes less than 6 seconds and has breaks or pauses in progress of task.
Component Function	All components are clearly representative of diagram and description and smoothly and successfully perform intended task	All components are representative of diagram and description, and successfully perform the intended task	1 component is not representative of diagram and description OR does not successfully perform the intended task.	More than 1 component is not representative of diagram and description OR does not successfully perform the intended task.
Machine Function	Machine completes all components in chain reaction & successfully completes identified task using creative and innovative components.	Machine completes all components in chain reaction & successfully completes the identified task.	Machine completes all components in chain reaction, and makes attempt at identified task but does not complete it successfully.	Machine does not complete chain reaction and/or does not make an attempt at identified task.

	Exceeding (4)	Proficient (3)	Approaching (2)	Developing (1)
Force Pairs	In addition to a 3, *Student accurately utilizes Newton's Third Law to justify identification of forces and determination of magnitude and direction.	Student correctly identifies force pairs for all components, including: *Object exerting & experiencing forces *Relative magnitude and direction of each	Student correctly identifies force pairs for most components, including: *Object exerting & experiencing forces *Relative magnitude and direction	Most components have errors or omissions in identification of force pairs.
Free Body Diagrams	Student produces accurate Free Body Diagrams for 6 component: includes action and reaction forces and follows all known FBD conventions	Student produces accurate Free Body Diagrams for 4 component: includes action and reaction forces and follows all known FBD conventions	Student produces accurate Free Body Diagrams for most components: includes action and reaction forces and follows all known FBD conventions	Most components have errors or omissions in completion of Free Body Diagrams.
Force and Motion Analysis	Student uses Newton's Third Law to accurately describe forces acting during each collision, and the resulting change in motion of both objects.	Student uses Newton's Third Law to accurately describe forces acting during each collision, and the resulting change in motion of 1 object.	Student uses Newton's Third Law to accurately describe forces acting during most collisions, and the resulting change in motion of 1 object.	Most components have errors or omissions in description of forces and resulting changes in motion.
Overall MS-ETS1-1 Score	Exceeding in components and function, and proficient in task time.	Proficient in most categories, and no category lower than approaching in one category.	Approaching in most categories, no more than one developing category.	Developing in two or more categories.
Overall MS-PS2-1 Score	Exceeds in force pairs &force/motion analysis; proficient in diagrams.	Proficient in most categories; no lower than approaching in any category.	Approaching in most categories, no more than 1 developing.	Developing in two or more categories.