Rube Goldberg Challenge

Each student group will design and build a Rube Goldberg machine that uses machines, joined together to create complicated device to complete a very simple task. Each student group must complete a simple task that was decided upon by the class, using more than no more than five steps (five machines). Student groups will be required to post their progress on Edmodo (or a similar site or app) throughout the project period. A completed project will include the Rube Goldberg machine, testing of the machine to complete the required task, and a presentation of at least one portion of the Rube Goldberg machine that describes how the unbalanced force caused a change in the direction of the motion or the speed of the machine.

Day 1 - Introduction of Rube Goldberg Machines -

1 - Introduce Rube Goldberg by showing a few of his cartoons, explaining that he used simple machines and common household items to build compound machines to complete a simple task.

   - **Differentiation** – assign students an introductory lesson on simple and compound machines, using Inventors Workshop, for homework or as an extension activity

2 – Instruct the students that they will be completing a brainstorming activity.

   During instructions make the following points:

   - students will work with their table group
   - each group will have a note taker and a timer
   - time is limited to 10 minutes for this activity
   - ideas will be shared with the class at the end
   - students will brainstorm where they have seen a Rube Goldberg machine
   - all ideas and thoughts are to be written down Provide all groups with either a whiteboard and marker or sheet of drawing paper

   **NOTE** - Have white boards and markers available already available on tables for student use.

3 – Call time at 10 minutes and select one student from the class to become the class note taker.
4 – Instruct students that they will be sharing their ideas to generate a class list.

During instructions make the following points:

• each student can add one idea
• no idea will be dismissed or disregarded
• time is limited to 10 minutes for this activity
• one student will write all class ideas on the white board/chalk board

**NOTE** – Limit this activity to 10 minutes, and you should be able to generate quite a list of Rube Goldberg machines that the students have seen.

5 – Show students various videos of Rube Goldberg machines. Many such videos can be found on YouTube or the Rube Goldberg site.

6 - Have students complete a “Round-Robin” discussion after each video.

During instructions make the following points:

• we will be watching various Rube Goldberg machines
• each video will have a Rube Goldberg machine, but they are being used in a variety of situations
• pay attention to the variety of actions each machine goes through to complete the final task
• make note of the final task completed by each Rube Goldberg machine
• at the end of this activity the class will generate a list of possible ending tasks for our Rube Goldberg machines
• all students will need a piece of paper and pencil to write their thoughts during the videos
• after each video table groups will complete a “Round-Robin” discussion

**NOTE** – Limit this activity to 10 minutes, you should be able to show 2-3 videos.

7 – After showing two or three videos, re-visit the cartoons of the Rube Goldberg machines.
Have the students complete a Shoulder-Partner discussion about the actions and final tasks for each Rube Goldberg machine.

During instructions make the following points:

- with your shoulder partner you will review two Rube Goldberg machines
- discuss with your shoulder partner the actions and final tasks completed by the Rube Goldberg machine
- each shoulder partner pair will generate a list of actions and final tasks that they will then share with their table
- each table will generate a final list of actions and tasks

**NOTE** - Limit this activity to 10 minutes.

Exiting class, have students complete the following questions as an exit slip:

**A - What is a Rube Goldberg machine?**
- A Rube Goldberg machine is a series of machines that when joined together complete one final task. Some students may even answer that it is a series of simple and compound machines that completed a single task.

**B - What is your choice for a final task for our Rube Goldberg machines?**
- Student answers will vary.

**NOTE** – I collect the exit slips and check for understanding of a Rube Goldberg machine and to generate a list of ending tasks. By collecting their slips and generating a list of tasks, I can vet the tasks before presenting them to the class for voting. This will facilitate time and success rate of the Rube Goldberg machines. Many students want to make the final task to complicated or difficult.
Day 2 - Review and Drawing/Diagramming (Initial Phase) -

Review of forces, motion, and speed

1 – Instruct the students that they will begin their Rube Goldberg machines today by completing an initial drawing/diagram.

   During instructions make the following points:
   
   • the learning goal for the next several days will be “The students will understand that unbalanced forces acting on an object causes a change in the direction of motion, speed or both.”
   • before beginning the drawings/diagrams, we must review forces, motion and speed.
   • after reviewing forces, motion, and speed, the class will select the final task to be completed by the Rube Goldberg machines.

   NOTE – The Rube Goldberg machine is a culminating activity, students should have already learned about forces, motion, and speed. The review shouldn’t take more than 10 minutes to complete.

2 – Explain to the students that first they will review forces, motion and speed by completing a “Stand-Up/Touch-Down” activity.

   During instructions make the following points:
   
   • before completing the “Stand-Up/Touch-Down” review, students will discuss forces, motion, and speed with their face partners, shoulder partners or table groups
   • remind the students of the rules of the “Stand-Up/Touch-Down” activity

3 – Giving the students think time, have them “think” about the following question (30 seconds think time):

   A - What is a force?
   • A force is either a push or a pull.

4 – Have the students “Rally Robin” with their face partner the definition of a force.
5 – Randomly select a few students to give the definition of a force and finally writing the answer on the white board.

6 – Giving the students think time, have them “think” about the following questions (30 seconds of think time):

   A - What is motion?
   • Motion is a change in position from the original position.

   B – What causes motion?
   • An unbalanced force causes motion.

7 – Have the students “Rally Robin” with their shoulder partner the answers to the above questions.

8 – Randomly select a few students to give the definition of motion and how motion is caused, ultimately writing the answer on the white board.

9 – Finally, ask the students to think about the answers to the following questions (30 seconds of think time):

   A – What are the variables in speed?
   • The variables of speed are distance and time.

   B – How do you know an object has gained speed?
   • An object gains speed when it moves a distance over a period of time.

10 – Have the students “Rally Robin” with their tables the answers to the above questions.

11 – Randomly select a few students to give the definition of speed, finally writing that response on the white board.

12 – Tell the students that they are now doing to complete a “Stand-Up/Touch-Down” activity as a check for understanding.

   During instructions make the following points:

   • remind the students of the rules for a “Stand-Up/Touch-Down” activity
   • when asking the questions, you will make sure to announce the new question so that the students know you are asking a new question
13 – Ask the students the any of the following questions (or make the following statements) as a check for understanding:

**NOTE** – Erase the notes on the whiteboard.

A – If I am walking around the room, I am exerting a force.
   • Students should stand up.
B – When I stop walking, I have balanced forces (excluding the force of gravity).
   • Students should stand up.
C – When I sit down I have balanced forces.
   • Students should sit down.
D – If I am writing with a pencil, my hand is in motion.
   • Students should stand up.
E – When I am writing my hand has “speed.”
   • Students should stand up.
F – A car driving around a track has balanced forces, which are causing it to move.
   • Students should sit down.
G – The car driving around the track has unbalanced forces, which are causing it to move.
   • Students should stand up.
H – Any object that has unbalanced forces acting on it will move in the direction of the force.
   • Students should stand up.
I – An object that is in motion also has speed.
   • Students should stand up.
J – Unbalanced forces, motion, and speed are all related.
   • Students should stand up.

**NOTE** – At any point during the check for understanding, you can do a quick review for those that are having a difficult time. Also, if this is not something you do regularly: try any method to check for understanding that works in your class.

**Drawing/Diagramming (Initial Phase)**

1 – Explain to the class that you tabulated the results for the final task for their Rube Goldberg machine.

2 – Post on the board the final task selected by the majority of the class.
3 – Have the students organize in groups of four - five students; this will be their group for the remainder of the lesson.

4 - Instruct the student groups that they are about to complete a "Draw-Round-Robin."

During instructions make the following points:

- the groups are completing a “Draw-Round-Robin”
- this drawing/diagram is simply the initial diagramming phase to “just get the juices flowing”
- while drawing/diagramming keep in mind the materials that are available in the classroom
- the drawings/diagrams do NOT have to be perfect, again this is the initial phase
- this will be a timed activity, each student will get 5 minutes to complete their portion (total time allotted for drawing/diagramming is 20-25 minutes)
- timing of this portion of the activity is simply one way to encourage all students to get their ideas on paper
- instruct the students on the steps of a “Draw-Round-Robin”
- students MUST pay attention to details and be neat during the re-drawing/diagramming phase
- the re-drawing/diagramming MUST be completed by the end of the class period

5 – Pass out drawing paper and pencils to each group. To facilitate/speed up this process assign the following jobs to the students.

  a. student 1 – drawing paper
  b. student 2 – pencils (colored or standard)
  c. student 3 – erasers
  d. student 4 (and possibly 5) – clear table and space for drawing

6 – Using a timer that is available for the students to see begin timing this activity. Approximately 5 minutes before the end of the activity, remind the students of the time.
7 – During this activity circulate in the class to provide support, ensure on-task behavior and to ask the following questions:

A - Describe a Rube Goldberg machine.
   • A Rube Goldberg machine is a series of machines that complete a final task.

B - What is the final task the class decided upon for our Rube Goldberg machines?
   • Answers will vary depending upon your class. Remember that this was decided upon by the class in the previous activities.

C - What are your general ideas for your portion of the Rube Goldberg?
   • Student answers will vary.

D - With your portion, where will your unbalanced force be? How do you know that force will be unbalanced?
   • Student answers will vary for the location of their unbalanced force. The unbalanced force will cause some sort of motion within the Rube Goldberg machine. Motion is defined as a change in position.

E - Will that force also cause a change in speed?
   • The force should cause a change in speed; speed is the change in distance over a period of time. Therefore any type of motion is causing speed.

F - What materials are you considering using?
   • Student answers will vary; continue to probe regarding their material choices.

8 – Call time (the groups should have had a minimum of 20 minutes of time to work on their drawings/diagrams), and explain that the groups are now going to complete a “Heads-Together” activity.
9 – Instruct the student groups that they are about to complete a "Heads-Together" activity.

During instructions make the following points:

• allow each student to explain their portion of the drawing/diagram, and their justification for adding that particular drawing
• after everyone shares, the groups should then make corrections or additions to their drawings/diagrams
• groups should also discuss where the unbalanced forces are located and how those forces will cause a change in motion and/or speed in their Rube Goldberg machine
• as a final discussion point in the “Heads-Together” activity have the groups decide upon their most unusual portion of their proposed Rube Goldberg machine
• this activity will be timed as well, 10 minutes will be allotted to discuss, make corrections, identify unbalanced forces and changes in motion or speed, and the most unusual portion

10 - Ask for a student volunteer from each group to describe their most unusual portion of the Rube Goldberg.

Make sure to address the following points:

A - Is there any unbalanced force in this portion of your Rube Goldberg machine?
• There should be an unbalanced force in this portion.

B - How will you know if this force is unbalanced?
• Motion will be caused and there is a change in speed.

C – Is gravity a factor in this portion of your Rube Goldberg?
• Gravity will affect every movement in the Rube Goldberg machine; unless you taught this specifically during your unit on gravity then answers will vary. Most students will be able to explain that gravity acts downward, so if something is falling or being thrown then gravity is most definitely working on the machine.

11 - Have students add their names to the back of their drawing and post the drawings around the classroom.
12 – Complete a “Thumbs-Up/Thumbs-Down” final check for understanding as an exit activity.

Make the following statements for the final check for understanding: *(THUMBS SHOULD BE UP FOR ALL STATEMENTS)*

A – Motion is caused by unbalanced forces.
B – Motion is in the direction of the force.
C – Speed is a factor of distance and time.
D – Motion is a change in position caused by a force.

**NOTE** – Make a note for any student that had a difficult time with the check for understanding and meet with them during the next class.
Day 3 – Revising Drawings/Diagrams -

1 – As students enter the class, have one student per group get their “Draw-Round-Robin” drawing/diagram.

2 – Instruct the students that they will be making a T-Chart of the pros and cons of their proposed Rube Goldberg machine, and re-drawing their drawing/diagram.

During instructions make the following points:

• student groups will make a T-Chart of the pros and cons of the initial drawing/diagram
• make a list of the proposed changes you will make to your new drawing/diagram based on the pros and cons
• after completion of the pros and cons list, groups will re-draw their drawing/diagram
• during re-drawing groups will also make notations for unbalanced force, their location, and how that force changes motion and speed also, a list supplies will be generated by the group

To facilitate this part of the activity I suggest assign “jobs” to the students:

a. students 1 and 2 – re-draw/diagram
b. student 3 – make notations of the unbalanced forces, change in motion and speed
c. student 4 – make a list of the supplies necessary to build the Rube Goldberg
d. student 5 – work with students 3 and 4, and ask questions

Also to facilitate completion of this activity include:

provide sticky notes for the students that are making notations of the unbalanced forces, changes in motion and speed

provide notebook paper for the student(s) making a list of supplies
3 - Circulate during this activity, as many groups will need guidance, many of the groups will have complicated plans, encourage them to plan for the parts that will be easier to build and yet provide function.

   Also, while circulating probe the groups regarding the following points:

   • Unbalanced forces
   • Motion
   • Speed
   • Materials
   • Tasks per group member (this will be critical to have the students begin thinking of their specific role during building)

   NOTE – Make sure to touch base with the students from the previous day that were having a difficult time with their response to forces, motion, and speed. Consider having stations available for review.

4 – As student groups completed their “Pros and Cons” list, and only AFTER you have questioned the groups on the points mentioned above provide each group with a NEW sheet of drawing paper.

5 – Continue to circulate through the class ensuring that students are on task and completing the required activities.

6 – Approximately 15 minutes before the end of class, remind the students that this portion MUST be completed before the end of class and that there are 10 minutes remaining in the class period but only 10 minutes of work time available.

7 – Approximately 5 minutes before the end of class, have the student groups begin cleaning up their work stations.

To facilitate clean up assign the following tasks to the students:

   a. students 1 and 2 – write student names on the back of the drawing/diagram and staple the new diagram on TOP of the original drawing/diagram
   b. student 3 – return remaining sticky notes to the class supplies
   c. student 4 – return any other borrowed supplies to their proper location
   d. student 5 – turn in the drawings/diagrams to the teacher
Day 4 - Constructing Rube Goldberg Machine (Day 1) -

1 - Student groups will build their proposed Rube Goldberg machines, recording and posting their progress using Edmodo (or similar site or app), YouTube (with parent approval), or any other visual method.

2 - During the building phase student groups will be in multiple stages of completion. You will have to set an absolute completion date, if not student groups will continue to build and modify. I usually set this as a maximum of three class periods for building and a single class period for testing.

3 - At the beginning of each class period, remind student groups that they will need to record their progress and post on Edmodo (or similar site or app).

NOTE – I have a class set of tablets that my students have access to, however, at least one student per group will probably have a smart device of their own.

4 – While students are working on the building of their Rube Goldberg, continually circulate through class providing support as needed.

5 - Approximately **10 minutes before the end of the class** period, warn the student groups of the time.

6 - Approximately **5 minutes before the end of the class** period, have the student groups begin cleaning up.

Assign responsibilities to group members:

   a. student 1 - return unused lab materials to their proper location
   b. student 2 - clean the desk with paper towels and pick up trash
   c. students 3 and 4 - post group progress to Edmodo (or similar site or app) and return class tablets to the charging machine
   d. student 5 - write student names on a sticky note and put it on the Rube Goldberg, and place the Rube Goldberg in a safe location
5 - At the end of the day 1, mention to the class that anyone with their groups approval may work on building at home. But that the work they complete at home MUST be transported to school and be able to be attached to the work completed.

**NOTE** - When you allow the students to build some part of their Rube Goldberg at home, there is always that possibility that there will be parent or adult participation. You have to decide how much parent involvement will "bother" you or impact final projects.

6 – While circulating through the class, talk with each student regarding their understanding of the project and how the student feels going forward with the project. Make note of any student that is comfortable or unable to express a proper understanding of the project.
Day 5 - Constructing Rube Goldberg Machine (Day 2) -

1 – As students enter class have them get their Rube Goldberg machine and sit in their groups.

2 – Instruct students on the following:

   • today is day 2 of 3 of the building phase
   • students groups should be completing their initial building of their Rube Goldberg and moving towards their testing phase
   • students groups should be documenting changes and testing of their Rube Goldberg machines

3 – Circulate through the class, providing support for supply suggestions, building, and testing of the Rube Goldberg machines.

   **NOTE** – Based upon your check for understanding from the class before, make a point to talk with each student that was uncomfortable and offer them an alternative assignment.

4 - While circulating, discuss with the groups that there will be a final presentation required, and continually probe for understanding of the project and their understanding of the science content.

   At this point most groups should have a good portion of their Rube Goldberg machine built so while circulating ask for the groups to “start” their machine. This is the time when you can provide guidance for building (material, spacing, timing, force suggestions).

   **NOTE** – any group that is having difficulty building their Rube Goldberg, consider offering an alternative assignment for the individual students.

5 - Approximately **10 minutes before the end of the class** period, warn the student groups of the time.
6- Approximately **5 minutes before the end of the class** period, have the student groups begin cleaning up the lab supplies and storing their Rube Goldberg machine.

a. **student 1** - return unused lab materials to their proper location  
b. **student 2** - clean the desk with paper towels and pick up trash  
c. **students 3 and 4** - post group progress to Edmodo (or similar site or app) and return class tablets to the charging machine  
d. **student 5** – return the Rube Goldberg to a safe location
Day 6 - Final Building Day and Practice Testing Day -

1 – As students enter class have them get their Rube Goldberg machine and sit in their groups.

2 – Again, instruct students on the following:
   - today is day 3 of the building phase BUT groups MUST also test their Rube Goldberg machines
   - students groups need to continue to document any changes to their Rube Goldberg machine, but will also document any testing the group completes

3 – Circulate through the class, offer suggestions for building, and spacing again.
   
   You may have three different stages of the projects at this point:
   - Building groups
   - Testing groups (and re-building as necessary)
   - Alternative assignment groups

Ask all groups the following probing questions:

A - Where is the initial unbalanced force?
   - The initial unbalanced force is at the beginning of the machine, however some students may pick up on the fact that when they move the initial starting mechanism that is an unbalanced force.

B - Did this unbalanced force cause a change in motion or speed?
   - This unbalanced force, as with all unbalanced forces, causes both a change in motion and speed.

C - Where is the change in motion and speed begin?
   - The change in motion and speed begins when the force causes the motion.

D - How did that unbalanced force affect the motion and speed?
   - The unbalanced force causes a change in the motion in the direction of the force and causes an increase in speed.

E – If you increased the amount of force at the beginning, how would that affect the speed and direction of motion? Justify the answer.
   - The increased force would not affect the direction of motion; however it would increase the speed. No matter how much force is applied the direction of motion will be in the direction of force, however an increased force will cause an increase in speed.
4 - Approximately **10 minutes before the end of the class** period, warn the student groups of the time.

5 - Approximately **5 minutes before the end of the class** period, have the student groups begin cleaning up the lab supplies and storing their Rube Goldberg machine.

   a. **student 5** - return unused lab materials to their proper location  
   b. **student 4** - clean the desk with paper towels and pick up trash  
   c. **students 2 and 1** - post group progress to Edmodo (or similar site or app) and return class tablets to the charging machine  
   d. **student 3** – return the Rube Goldberg to a safe location

6 – When dismissing the students, remind them that during the next class period that **ALL student groups will be testing their Rube Goldberg machine**. The students with alternative assignments will present their Rube Goldberg.
Day 7 - Testing the Rube Goldberg Machines -

1 - As students enter class instruct them to pick up their Rube Goldberg machines, and to “mentally” prepare for the testing phase.

**HINT** - To build excitement you can play festive music and have your class set-up in a “competition” format.

2 – Instruct the students on the following:

- today ALL groups will test their Rube Goldberg machine
- students with alternative assignments, will also present their assignment to the class
- while testing or presenting, the “audience” will be considerate of other groups
- while testing or presenting, one student per group will document the testing or presentation
- there will be a time limit per group and student presentation of 5 minutes, this will allow time at the end of class to post documentation of the test or presentation
- when you are finished testing or presenting return your Rube Goldberg machine/alternative assignment to a safe location

3 – After each group has tested their Rube Goldberg (or student has presented their alternative assignment), provide positive feedback to the groups and/or students.

4 – Once all groups or students have tested or presented their alternative assignment allow students to post their documentation.

5 – Approximately **20 minutes before the end of class**, announce that you will need the entire class attention to present the requirements for their final assessment.
6 – Instruct the students on their final assessment requirements.

• ALL students will complete a presentation (method of their choice)
• presentations must include a portion of the groups Rube Goldberg machine
• any documentation of the group Rube Goldberg machine is available on the class posting site (Edmodo (or any similar site app))
• presentations will be completed for homework (I give my students a week to complete their final presentations)
• presentations are to be posted on Edmodo (or any similar site app)

7 – Instruct the students on the rubric for their presentation.

• project the Rube Goldberg Challenge Checklist
• post the Rube Goldberg Challenge Checklist in a location that is easily accessible to all students (I use my class website)
• allow students to ask clarifying questions