Teacher Guide

Rube Goldberg Machine

Wonderville.ca Science Challenges
Grade 8: Mechanical Systems

Another Amazing Resource From science alberta FOUNDATION

GRADE 8 Wonderville.ca SCIENCE CHALLENGE

We are pleased that you will be part of the Science Alberta Foundation Grade 8 Wonderville.ca Science Challenge. The challenge is focused on the Mechanical systems and is designed to integrate with your science class. This guidebook will assist you in making this a successful project for you and your students. If you choose, you can also run this as an extra-curricular activity.

The mechanical systems unit has a strong focus on simple machines and we have emphasized this in the challenge. We ask students to be "Junior Engineers" and apply what they have learned in class to design a Rube Goldberg device using a variety of simple machines.

Rube Goldberg devices are, in the words of the inventor, "symbol of man's capacity for exerting maximum effort to achieve minimal results." Generally machines are used to exert a minimum effort for maximum results. Goldberg's inventions became so widely known that Webster Dictionary added the term "Rube Goldberg" to its listings, defining it as "accomplishing by extremely complex, roundabout means what seemingly could be done simply." http://www.rube-goldberg.com/

Science Alberta Foundation also has a crate for the mechanical systems unit. Filled with seven activities that help students visualize and understand simple machines, the crates are a great resource for your classroom. To book this crate visit: http://crates.sciencealberta.org/ We hope that your students enjoy this challenge and find creative solutions to the problem!

Science Challenge Details

The Challenge:

Students, in teams of 2-4 people, are challenged with inventing a Rube Goldberg device that can get a marble out of a plastic tube. Their challenge is to design a Rube Goldberg device to extract a marble from the tube supplied that fulfills the following requirements:

- Uses at least three simple machines: Lever, Inclined Plane, Wedge, Screw, Pulley, Wheel and Axle, Gears and Hydraulics
- Input (start the motion) can be one movement (push, drop, crank, pull etc)
- Last no longer than two minutes from initiating the first movement.

After they have built and tested their Rube Goldberg device they will need to film a video to upload to the Science Challenges website for both our judges and public viewing. In addition, students will need to post a drawing of your machine along with a picture and description. In their presentation the students will need to be able to discuss the following points:

- Introduce the team and discuss what type of simple machines the team used to lead up to the extraction of the marble?
- Indicate where the Lever, Inclined Plane, Wedge, Screw, Pulley, Wheel and Axle and Gears, and Hydraulics are within the Rube Goldberg device.

- Indicate why the team chose those machines and if you could start again, what they would change or do differently.

NOTE – THE TEAM MAY USE PARTS OF LEGO, MECHANO, K'NEX ETC WHEN BUILDING THIS STRUCTURE, BUT NOT FOLLOW ANY PRE-MADE DESIGNS GIVEN BY THOSE PRODUCTS.

Design Strategy

To help your students design a Rube Goldberg device get them to start with how they are going to extract the marble from the tube. Perhaps a string is going to pull the tube to tip it over. Have them work their way backwards from there. How is the string going to be pulled? Maybe a weight will pull it? Or a mousetrap – Yeah... a mousetrap! How will the mouse trap be triggered? By working backwards it will help them see the design process and how all the machines work together.

Have them come up with more than one way to extract the marble from the tube. Perhaps a lever arm will be used in place of the string to extract the marble. Again, have them think backwards as to how the lever arm will be moved. Finally, the most important step in the process – Test everything together.
http://www.marquette.edu/engineering/pages/Rube/making.html

Time Lines

February 4, 2008 – Registration opens for Science Challenge
February 25 – March 5, 2008 – Packages and digital cameras sent to the schools upon receipt of School Registration and if school has not previously received a camera. A camera will only be sent to schools with 3 or more teams – there are a limited number of cameras. (Grade 7, 8 & 9 challenge together) (NOTE – this camera must be returned if no student teams complete the challenge)
March 3, 2008 – Registration closes
April 1, 2008 – Public Voting Starts
April 9, 2008 – All submissions are due
April 12 – 18, 2008 – First Round of Judging
April 21, 2008 – Second Round of Judging
April 25, 2008 – Prizes awarded

Registration Information

Registration will open on February 4, 2008. Registration in the challenge is restricted Alberta Schools with Grade 7, 8 or 9 classes and is done on a first come first serve basis. Early registration will ensure that your school can participate.

Participation in the Science Challenge requires that your school has access to a computer connected to the internet and a digital device capable of recording video in .mpeg, .mov,

.avi and .wmv formats. Science Alberta Foundation provides a digital camera to all schools who register with a minimum of five teams and who have not previously participated in the Science Challenge. This is to help those schools who might not have access to a digital recording device. The cameras stay at the school after the challenge has finished.

Saving Student Work

To make finding information easier for the teams, set up individual team folders on your server – have your tech support set this up in advance and show students how to save into it. This will ensure that all their information is saved in one place and will make it easier when they have to upload their picture, diagram, and video to the website. As well, this allows all team members to have access to the documents.

When they save any of their work have them save it in the format "teamname_schoolname_object" where object is image, drawing or video. This will help us if there are any problems with the files.

Description and Image

Each team will need to submit a Description and Image of their project. The description should cover the same information as the video presentation. The description is designed to help the judges make a decision on how well the team understands the scientific principles behind their design. To submit the description, simply copy and paste from any word processing program or type directly into the description box.

The image should clearly show the structure that the students designed. The photos should be between 3-5 megapixels in size. When your students save their image to their folder call it "teamname_schoolname_image". All photos need to be a .jpeg (.jpg) format.

Scientific Drawing

The scientific drawing needs to be scanned into the computer at low resolution not print resolution. The scanned diagram must be uploaded in a picture Follow the instructions provided by the scanner you have at your school. Have students save scanned diagram to their folder and call it "teamname_schoolname_drawing". Ensure that the drawing is saved with a .jpeg (.jpg) extension. No other formats will be accepted.

Video Instructions

Use any Digital Camera to film the students presentations. At the start of March there will be a video on how to film a presentation. Watch this video with your students for tips and tricks to help their presentation stand out from others.

Once the video is filmed have the students upload the video to the computer and have them save it in their folder and call it "teamname_schoolname_video".

The video must have a minimum resolution of 640x480. The video must be in one of the following formats: .mpeg, .avi, .mov., .wmv. These are the ONLY formats that will be accepted. NOTE: Camera phones will not save in any of these formats.

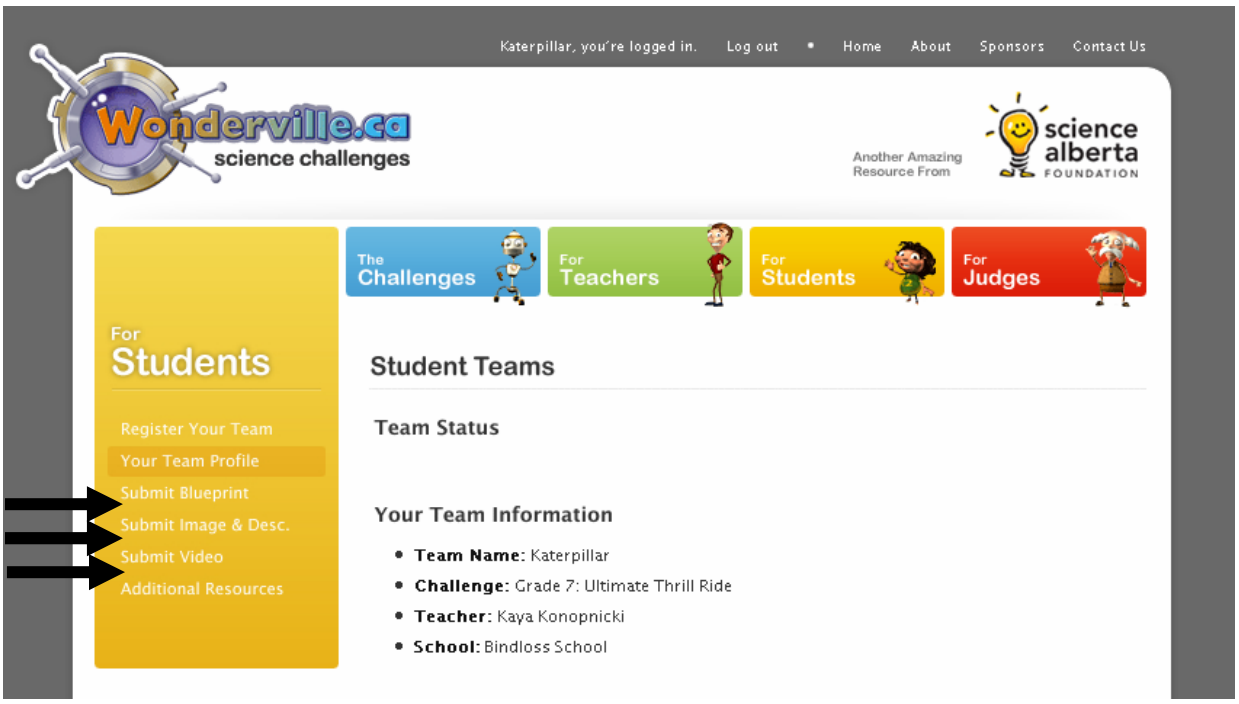
If you have any problems please contact Kaya Konopnicki at 403-220-0077 ext 234 or sciencechallenges@sciencealberta.org.

Uploading Instructions

Once students have captured their information they will need to post it to the web. Please test this before you have students upload their information so that if there are any technical issues we can help you work them out.

To upload information, follow the step by step process.

STEP 1
Teams navigate to the Submit Image & Desc., Submit Drawing, or Submit Video pages.



On each page they will be asked to upload the required information:

- Image & Description –
- A clear photo of their ride - .jpeg (.jpg) extension
- A written description that tells judges about their device. There is a text box that they can post this information into.
- Scientific Drawing - .jpeg (.jpg) extension
- Video - .mpeg, .mov, .avi or .wmv extension

NOTE: No other formats will be accepted. If you have problems uploading files and they have the correct extension please contact Science Alberta Foundation.

STEP 2

Once they have uploaded all the required data they click on the 'Submit Page' button. Teams do not have to upload all their data at the same time. They can submit any part of their data at any time.

STEP 3

Now that they have submitted their information they can go and look at it by clicking on the 'Our WEB page' tab at the top.

Publishing Team Video, Scanned Drawing and Photo of Ride

Once the Students have submitted their information you as their Teacher must approve them. It is an easy but critical process. Science Alberta Foundation will not approve any files.

STEP 1:
Login to the Science Challenges site as yourself (Teacher account)

STEP 2:
Navigate to the 'Manage Teams' section there you will see a screen that shows all your teams and the status of each element they have been asked to upload:

Looking through the teams you will be able to tell at a glance if teams have:
Not submitted any information for a specific element (RED DOT)
Submitted information that requires your approval (YELLOW DOT)
Submitted information and you have approved it (GREEN DOT)

To approve information (that is to say you make the information viewable to the public) simply click on a Team Name and check off the box saying "Approved".

Please note that anytime a student submits information you will have to approve it. For example if they submitted a video and you approved it and then they modify their video and upload a new version you will need to approve that new version.

You can also change the status of any piece of information from "Approved" to "Pending your approval" by removing the check beside "Approved".

FOIP

An entry form and sample letter (See Appendix 1 and 2 for an entry form and a sample letter) must be sent home to inform parents that the work the student is doing will be posted on the Internet. The name of their team will be published along with photos or videos of the student will be posted for public viewing on the Internet. Science Alberta Foundation requires that you submit FOIP forms for each student on each team before any information for that team is available to either the judges or the public.

Team Entry Form

The team entry form allows the child to participate in the challenge. It must be signed and returned before students participate in the challenge. Please send completed forms to Science Alberta Foundation by mail, fax or e-mail and retain a copy at the school. See Appendix 1 for an Entry Form.

Sample Letter to Parents

A sample letter to parents is included in Appendix 2. Modify the letter as required; however, parents do need to be notified that their child's work will be on the Internet. Note that the videos will be available publicly. There is a sample letter as a word document on the Science Challenge site in the Teachers section.

Internet Resources

- Wonderville – Medieval Levers; Robot Factoryhttp://wonderville.ca/
- Wikipedia – Rube Goldberg http://en.wikipedia.org/wiki/Rube_Goldberg
- Simple Machines – list of many sites that explain about machines - levels varied grade 4 – grade 9 http://edtech.kennesaw.edu/web/simmach.html
- Simple and Complex Machines http://sunshine.chpc.utah.edu/javalabs/java12/machine/index.htm
- MiKids.com – Simple machines http://www.mikids.com/Smachines.htm
- A series of "Rube Goldberg" devices showing everyday and household items that can be used http://www.youtube.com/watch?v=JD8P4fE8Yn0

Prizes

	Money for School's Science Program	Gift Certificate for Teachers	Gift Certificate for each Student in the team.
Best Overall	$500.00	$100.00	$50.00
Most Creative	$300.00	$60.00	$25.00
Best Presentation	$300.00	$60.00	$25.00
Best Diagram	$300.00	$60.00	$25.00
Longest Machine (time)	$175.00	$30.00	$20.00
Most Simple Machines used	$175.00	$30.00	$20.00
Favorite Machine (Public Voting)	$175.00	$50.00	$50.00

Team Worksheets

These are suggestions to help students get organized as a team. You do not need to use them and any changes can be made. However, students need to follow the Challenge protocols. See Appendix 3

Judging

The Scoring Rubrics that will be used to score the Team's Project are in Appendix 4. Ensure that you have read through all the scoring criteria and pass the information on to your students. These are the same sheets that the judges use to score the project.

In addition to the formal rounds of judging the Science Challenge will also have public judging this year. We encourage you to tell parents to go online to the Science Challenge website and vote for their favorite mahines. There is a prize for the team that scores the highest during public voting. Remember – the sooner your students post their information the sooner people can begin voting for their projects.

Information Sheet – Simple Machines

This is a two page sheet with very brief definitions given for the various simple machines referred to in the grade 8 science curriculum. Appendix 5

Lessons

There are some sample lessons for you to use. These do not need to be followed and of course can be changed at your discretion. There are 10 suggested lessons – some of these are construction days and the last two are the presentations and uploading of the projects, so a computer or two will be needed for this. These do not include actually teaching of the unit concepts. These can be scattered in between each lesson. Appendix 6.

Appendix 1 – Entry Form

Team Entry Form

Print one per student

Please sign this form to indicate that you have read the attached letter and agree to the statement at the bottom

Name of Team _____

Student Name_____

School _____

Phone # ( ) _____ Fax # ( )_____

City/Town_____

Coordinator in school _____Teacher _____

_____ _____

Teacher's Signature Coordinator's Signature

_____ _____

Parent/Guardian Signature Student Signature

Date: _____

I/We (parents(s) guardian(s) have read and understand the rules and guidelines for the 2008 Science Alberta Foundation Grade 8 Challenge. As the parent(s) (or guardian(s), I/we understand that the Science Alberta Foundation Grade 8 Challenge is an Internet event; my child's work (including a video presentation of their machine) will be posted on the Internet. My child may be interviewed by the media; and his/her name, picture of project, school phone number, team name, and school will be available to the Science Alberta Foundation Grade 8 Challenge, their volunteers, and the media, for up to two years after the 2008 Challenge.

Appendix 2 – Letter to Parent

Sample Letter

Date

Dear Parent/Guardian;

As part of our Grade 8 science program, our class will be entering the Science Alberta Foundation Grade 8 Challenge. The Challenge will give your son/daughter an opportunity to use the information we are learning in – Unit D "Mechanical Systems".

Students, in teams of 2-4 people, are challenged with inventing a Rube Goldberg device that can get a marble out of a plastic tube. Their challenge is to design a Rube Goldberg device to extract a marble from the tube supplied that fulfills the following requirements:
Uses at least three simple machines: Lever, Inclined Plane, Wedge, Screw, Pulley, Wheel and Axle, Gears and Hydraulics
Input (start the motion) can be one movement (push, drop, crank, pull etc)
Last no longer than two minutes from initiating the first movement.

After they have built and tested their Rube Goldberg device they will need to film a video to upload to the Science Challenges website for both our judges and public viewing. In addition, students will need to post a drawing of your machine along with a picture and description. In their presentation the students will need to be able to discuss the following points:
Introduce the team and discuss what type of simple machines the team used to lead up to the extraction of the marble?
Indicate where the Lever, Inclined Plane, Wedge, Screw, Pulley, Wheel and Axle and Gears, and Hydraulics are within the Rube Goldberg device.
Indicate why the team chose those machines and if you could start again, what they would change or do differently.

NOTE – THE TEAM MAY USE PARTS OF LEGO, MECHANO, K'NEX ETC WHEN BUILDING THIS STRUCTURE, BUT NOT FOLLOW ANY PRE-MADE DESIGNS GIVEN BY THOSE PRODUCTS.

Attached is a form for you to sign that indicates you understand he/she will be entered into the challenge and that his/her work will be posted on the Internet. His/her name will not be posted on the Internet. If you have any questions please call me at ***

Yours sincerely,

Appendix 3 – Worksheets

Team Worksheet 1: The Challenge

Hello Junior Engineers! We here on Wonderville hear that you've been studying Simple Machines. We are looking for a team that can use simple machines and show us how they can work together to accomplish a task. We're looking for you to build us a machine that uses as many simple machines as possible to extract a marble from a tube.

The machine you are inventing is part of a group of machines called Rube Goldberg devices. These machines use a series of simple machines to accomplish a task. We want to learn as much about simple machines as possible – so remember use as many different types as you can.

We are looking for the team who can best show us how simple machines work. Here are some rules to let you know what we're looking for:

- Work in teams of no more than 4 people.
- Design a Rube Goldberg device to extract a marble from a tube. Make sure your machine fulfills the following requirements:
- Uses at least three simple machines: Lever, Inclined Plane, Wedge, Screw, Pulley, Wheel and Axle, Gears and Hydraulics
- Input (start the motion) can be one movement (push, drop, crank, pull etc)
- Last no longer than two minutes from initiating the first movement

After you've built and tested your Rube Goldberg device we need you to present it to our panel of judges. Film a presentation to show our panel of judges your fantastic machine and post it to the science challenges website. They are also going to need a drawing of your machine along with a picture and description.

For your presentation you need to be able to discuss the following points:
Introduce the team and discuss what type of simple machines the team used to lead up to the extraction of the marble?
Indicate where the Lever, Inclined Plane, Wedge, Screw, Pulley, Wheel and Axle and Gears, and Hydraulics are within the Rube Goldberg device.
Indicate why the team chose those machines and if you could start again, what would you change or do differently.

Team Worksheet 2 – Brainstorming/Simple Machines

Think about the Rube Goldberg device(s) you just saw in the video and list as many of the actions that your team can remember that took place.

After the discussions of Lever, Inclined Plane and Wedge indicate on the chart below which action would fit those machines.

After the discussions of Pulley, Screw, Wheel and Axle, and Hydraulics indicate on the chart below which action would fit those machines.

Action	How did it work?	Simple Machine Used Lever, Inclined Plane and Wedge, Screw, Wheel and Axle, and Hydraulics

Team Worksheet 3 – Design Phase

The task is to extract a marble from a tube using a Rube Goldberg device that will fulfill the following requirements:

- Use at least three machines of Lever, Inclined Plane, Wedge, Screw, Pulley, Wheel and Axle, Gears and Hydraulics
- Input (start the motion) can be one movement (push, drop, crank, pull etc)
- Last no longer than two minutes from the starting movement

Start with how you are going to extract the marble. Brainstorm ideas on how to get the marble out of the tube and then what will happen before that etc.

Fill in the chart with team's ideas and on a separate piece of blank paper start the initial drawing.

Action	Simple Machine	Materials

Team Worksheet 4 – Materials

Materials to bring from home and to get from school

Ask each member of the team to bring in various materials.
List who will bring what material on this sheet and each team member should put the items in their agenda. Decide what day the materials are to be brought to the class.

Name	Materials to be brought to class

Team Worksheet 5 – Building the Device

Your team gets to build a Rube Goldberg device using as many simple machines as you can to extract a marble from a tube. Below is your team's checklist to make sure all team members remember the criteria. This could take 2 or 3 days. Your teacher will let the class know how many class days you will have to build the device.

The challenge is to extract a marble from a tube using a Rube Goldberg device that will fulfill the following requirements:

- Use at least three machines of Lever, Inclined Plane, Wedge, Screw, Pulley, Wheel and Axle, Gears and Hydraulics. Remember – the more machines the better!
- Input (start the motion) can be one movement (push, drop, crank, pull etc)
- Last no longer than two minutes from the starting movement

Steps to take before and during building

- Make sure you have a preliminary drawing of the machine
- Look over your materials – Do you have all materials to get started?
- Let each team member choose a section of the project to build
- Reevaluate as the team goes
- Does it make sense?
- Do we have at least three different simple machines?
- Have we measured the distance when one section works?
- What else can we do or change to make it better?
- Do test runs.
- Troubleshoot and make the necessary modifications
- Start over if the project does not meet the requirements.
- Once the team is satisfied with the project, make final touches to make sure that the time from starting movement to extraction of the marble is no longer than 2 minutes.

Team Worksheet 5a – Scientific Drawing

As a team of Junior Engineers you must communicate to the panel of judges about your machine. Remember – the judges are looking for a diagram that identifies:

- all the simple machines (if you don't label them, they won't count!)
- all the materials you used
- time it takes to extract the marble

Be sure that your scientific drawing is clear, neat, and accurate.

What to Do

Use unlined paper, a sharp pencil, a good quality eraser and ruler.

Draw a side profile of your device.

Give yourself plenty of space. Your diagram should be at least 1/2 page in size. You need the space to add labels and captions to your drawing.

Neatly label the machines in your drawing. Make sure you label all the machines you use (Lever, Inclined Plane, Wedge, Screw, Pulley, Wheel and Axle, Gears and Hydraulics). Using a ruler, draw lines from the detail you are naming to the margins of the paper. Make sure the line clearly touches the part of the drawing you are labeling.

Neatly label all the materials you used. Using a ruler, draw lines from the detail you are naming to the margins of the paper. Make sure the line clearly touches the part of the drawing you are labeling.

Labels identify the parts of the object you are drawing. Place labels on the right side of your drawing unless putting them all on the one side would make your drawing cluttered. Use your ruler to draw lines to the different machines. Make sure none of your label lines cross.

Draw only what you see and keep your drawing simple.

Shading or colouring is not usually found on scientific drawings. If you want to indicate a darker area, you can use stippling (a series of dots).

Label the following: Title (name of device), Date, Team Name, Time it takes to extract the marble.

Time from start to finish: _____seconds.

Team Worksheet 5b – Sample Scientific Drawing

Team Worksheet 6 – Presentation

Clearly communicating your ideas to others is a very important part of being an engineer. As part of the challenge, your team must make a 1-2 minute video about your device. Each person on your team must participate in the video. Below is a sample outline of the topics to be covered.

Plan for the presentation to the judges – it is a critical component of where you get marks from the judges!

- Decide who will do each section of the presentation.
- Brainstorm ideas to include in each section
- Each team member should prepare one part of the presentation.
- Make sure you show your machine in action.
- Practice your presentation to be sure you have included all of the required information.
- Judges will be awarding points for presentations.

SPEAKER 1: Introduce your team and the device. Explain how your team came up with the concept and design.

_____
_____
_____
_____

SPEAKER 2: Explain the steps of the device. What are the simple machines you used?

_____
_____
_____
_____

SPEAKER 3: Discuss the forces on each of the different simple machines you used. (not on all machines – one of each type)

_____
_____
_____
_____

SPEAKER 4: Which parts of the device worked well? What would your team change if they could do the challenge again?

_____
_____
_____
_____

Appendix 4 Score Sheets

Scientific Drawing Grade 8 Challenge

TEAM NAME: _____

CATEGORY	Weight for Each Category	4	3	2	1	0
Accuracy	X2 (up to 8 points available)	The drawing accurately portrays the machine as seen in the picture and/or video.	The drawing is missing 1-2 parts as compared to the picture and/or video.	The drawing is missing 3-4 parts as compared to the picture and/or video	The drawing is missing 5 parts as compared to the picture and/or video	The drawing is missing 6 or more parts as compared to the picture and/or video
Machine identification	X2 (up to 8 points available)	95% or more of the machines have been identified	94-85% of the machines have been identified	84% -75% of the machines have been identified	74% - 50% oof the machines have been identified	Fewer than 50% oof the machines have been identified
Machine accuracy	X4 (up to 16 points available)	95% or more of the machines identified are labeled accurately	94-85% of the machines identified are labeled accurately	84% -75% of the machines identified are labeled accurately	74% - 50% of the machines identified are labeled accurately	Fewer than 50% of the machines identified are labeled accurately
Drawing - materials	X2 (up to 4 points available)	All materials have in the drawing been labeled. The materials are clear and easy to identify.	Almost all assigned materials (at least 85%) have been added. The materials are clear and easy to identify.	Almost all assigned materials (at least 85%) have been added. A few materials are difficult to identify.	Most materials are difficult to identify.	Almost none of the materials are added and most are difficult to identify.
Labels	X2 (up to 8 points available)	Every item that needs to be identified has a label. It is clear which label goes with which structure.	Almost all items (90%) that need to be identified have labels. It is clear which label goes with which structure.	Most items (75-89%) that need to be identified have labels. It is clear which label goes with which structure.	74% - 50% of the items that need to be identified have labels OR it is not clear which label goes with item.	Fewer than 50% of the items that need to be identified have labels OR it is not clear which label goes with item.
Title	X1 (up to 4 pts available)	Title is informative, centered, and larger than other text.	Title is informative and larger than other text.	Title is informative and centered.	The title is incomplete and centered.	The title is incomplete and is hard to identify.

General Formatting	X2 (up to 8 points available)	Unlined paper is used. The drawing is large enough to be clear (about 1/2 of a page of typing paper 8 ½ by 11). Team name and date are in the lower left corner. There is a section that includes Scale, distance and Time in lower right corner.	Unlined paper is used. The drawing is large enough to be clear (about 1/2 of a page of typing paper).Team name, date, scale, distance and time are included.	Unlined paper is used. The drawing is a little too large or a little too small. Team name, date, scale, distance and time included	Lined paper is used and only a few details are included (Team name, date, scale, distance, and time).	Lined paper is used AND/OR the drawing is much too small or much too large. No more details are included
Drawing - general	X1 (up to 4 points available)	Lines are clear and not smudged. There are almost no erasures or stray marks on the paper. Stippling is used instead of shading. Overall, the quality of the drawing is excellent.	There are a few erasures, smudged lines or stray marks on the paper, but they do not greatly detract from the drawing. Overall, the drawing is good.	There are a few erasures, smudged lines or stray marks on the paper, which detract from the drawing. Overall, the quality of the drawing is fair.	There are several erasures, smudged lines or stray marks on the paper, which detract from the drawing. Overall, the quality of the drawing is poor.	There are un-erased, smudged or stary marks on the paper which detract from the drawing. The overall machine is unrecognizable . Overall the quality of drawing is poor.
Spelling	X2 (up to 8 points available)	All words are spelled correctly in the title, labels and caption/description.	All common words are spelled correctly in the title, labels and description. 1-2 scientific words may be misspelled.	75% of the words are spelled correctly in the title, labels, and description.	74% - 50% of the words are spelled correctly in the title, labels, and description.	Fewer than 50% of the words are spelled correctly in the title, labels, and description.

Team Presentation Grade 8 Challenge

Team Name: _____

CATEGORY	Weight for Each Category	4	3	2	1	0
Function	X2 (up to 8 points available)	Device functions extraordinarily well, and no additional inputs are needed	Device functions well, and only one additional input was needed	Device functions pretty well, but needs two additional inputs	Device functions pretty well, but needs three additional inputs	Fatal flaws in function with complete failure or needs over three additional inputs were needed
Number of Simple Machines	X3 (up to 12 points available)	Group has used all 7 types of simple machines.	Group has used 5-6 types of simple machines.	Group has used 4 types of simple machines	Group has used 3 types of simple machines	Less than three simple machines were used by the group
Machine Information	X4 (up to 16 points available)	Accurate and detailed explanations were given of all the machines used to build their device.	Accurate and detailed explanations were given for some machines used to build their device Other machines are only mentioned.	Basic explanations were given for all of the machines used to build their device.	Basic explanations were given for some of the machines used to build their device. Other machines used are only mentioned	Machines are only mentioned, no explanations are given.
Construction Materials	X3 (up to 12 points available)	Group indicates why materials were selected and indicates how they were creatively modified in ways that made them even better.	Group indicates why materials were selected and indicates there was an attempt at creative modification to make them even better.	Group indicates why materials were selected but no creatively modification occurred. Materials performed well.	Group indicates why materials were selected but materials perfomed poorly	Inappropriate materials were selected and contributed to a product that performed poorly.
Modification/ Testing	X3 (up to 12 points available)	Clear evidence of troubleshooting, testing, and refinements based on data or scientific principles.	Clear evidence of troubleshooting, testing and refinements.	Some evidence of troubleshooting, testing and refinements.	Little evidence of troubleshooting, testing or refinement.	No evidence of troubleshooting, testing or refinement.
Filming	X3 (up to12 points available)	Video clearly shows the ride and students and is easy to follow	Video shows the ride and students and is easy to follow	Video is shaky and/or filmed sideways and is easy to follow	Video is difficult to follow	Video is shaky and or/filmed sideways and is difficult to follow

Speaking	X1 (up to 4 points available)	All team members spoke slowly and clearly	Three team members spoke slowly and clearly	Two team members spoke slowly and clearly	One team members spoke slowly and clearly	No team members spoke slowly and clearly
Enthusiasm	X1 (up to 4 points available)	Students are enthusiastic about their machine and vividly describe the details with hand gestures and movement or costumes.	Students are enthusiastic about their machine, and describe their ride without hand gestures and movement or costumes.	Students are neutral in describing their machine	One or more students describe the ride in negative terms	Students describe their ride in negative terms

Creativity Grade 8 Challenge

Team Name: _____

CATEGORY	Weight for Each Category	4	3	2	1	0
Time in seconds	X2 (up to 8 points available)	1min 45sec to 2 min	Greater than 1 min and less than 1 min 45 sec	Greater than 45 sec and less than 1 min	Greater than 30 sec and less than 45 sec	Less than 30 sec
Creativity	X3 (up to 12 points available)	The device was designed very creatively with many outstanding extra features that add to the structure in an exciting way	The device was designed creatively with some outstanding extra features that add to the structure in an pleasing way	The device was designed with some extra features that add to the structure	The device was designed with few extra features	The device was designed with no extra features
Construction Care Taken	X1 (up to 4 points available)	Great care taken in construction process so that the structure is neat, attractive and follows plans accurately.	Construction was careful and accurate for the most part, but 1-2 details could have been refined for a more attractive device.	Construction accurately followed the plans, but 3-4 details could have been refined for a more attractive device.	Construction is basic and no care has been taken for a more attractive device.	Construction appears careless or haphazard. Many details need refinement for a strong or attractive device.
Construction Materials	X3(up to 12 points available)	Unique materials were selected and creatively modified in ways that made them even better.	Suitable materials were selected and there was an attempt at creative modification to make them even better.	Suitable materials were selected.	Materials that were selected contributed to a device that performed poorly.	Only commercially available materials (i.e. K'nex, Lego) were used to build the device.

Overall Apperance	X1(up to 4 points available)	Great care taken in appearance of the ride, with additional features add a great deal to the overall appeal of the ride.	Care was taken with the appearance of the ride, and additional features increase the overall appeal.	Care was taken with the appearance of the ride but additional features added do not increase the overall appeal.	Care was taken with the appearance of the ride but no additional features were added to increase the overall appeal.	No Care was taken with the appearance of the ride and no additional features were added to increase the overall appeal.

Number of Machines
Team Name: _____

Number of Machines: _____

Time

Team Name: _____

Time it takes for machine to extract the marble:_____

Appendix 5 – Information Sheet on Simple Machines

Simple Machines

In this Challenge you will need to understand the different types of simple machines in order to build your Rube Goldberg machine to extract a marble from a tube. Here is a short synopsis of simple machines. More information can be found in your textbook, science books in your library and sources on the Internet sites your teacher will provide.
Rube Goldberg device: Of, relating to, or being a contrivance that brings about by complicated means what apparently could have been accomplished simply.
http://www.answers.com/topic/rube-goldberg

Lever: A lever is a board or bar that rests on a turning point. This turning point is called the fulcrum. An object that a lever moves is called the load. The closer the object is to the fulcrum, the easier it is to move. A hammer is a lever when it is used to pull a nail out of a piece of wood e.g. Bottle openers, Crow bars

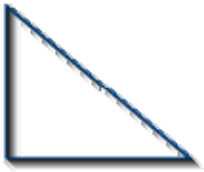
Inclined Plane: It is a flat surface that is higher on one end. You can use this machine to move an object to a lower or higher plane. Ramp, Slanted Road, Slide

Wedge: A wedge is a simple machine used to push two objects apart. A wedge is made up of two inclined planes back to back. These planes meet and form a sharp edge. This edge can split things apart. Knives, Axes, Forks, Nails

Screw: It is actually an inclined plane that winds around itself. A screw has ridges and is not smooth like a nail. Some screws are used to lower and raise things. Jar Lids, Light Bulbs, Stools, Clamps, Jacks

Pulley: This simple machine is made up of a wheel and a rope. The rope fits on the groove of the wheel. One part of the rope is attached to the load. When you pull on one side of the pulley, the wheel turns and the load will move. Pulleys let you move loads up, down, or sideways. Pulleys are good for moving objects to hard to reach places. Flag Poles, Clothes Lines, Sailboat, Blinds, Crane

Wheel and Axle: The axle is a rod that goes through the wheel. This lets the wheel turn. Cars, Roller Skates, Wagons, Door Knobs, Gears in Watches, Clocks, and Bicycles

 Lever	 Inclined Plane	 Wedge
 Screw	 Pulley	 Wheel and Axle

Sources
http://www.coe.uh.edu/archive/science/science_lessons/scienceles1/finalhome.htm
http://www.henry.k12.ga.us/cur/simp-mach/default.htm

Appendix 6 – Lessons

Lesson 1 – Introduction to Challenge and Rube Goldberg Devices

To explain to students the Science Challenge and put into teams – understand how teams work together

Time In minutes	Materials Needed	Program of Studies	Activity
20	TV or computer with LCD projector Videos	Unit D "Mechanical Systems" Alberta Grade 8 Science Curriculum http://www.education.gov.ab.ca/k_12/curriculum/bySubject/science/sci7to9.pdf www.wonderville.ca	Introduction to the Challenge What is it? How it fits into the curriculum "Mechanical Systems" – design and function, systems and subsystems, transmission of force and motion, simple machines, mechanical advantage, hydraulics and pneumatics. Watch the videos Discussion of the challenge Rube Goldberg – talk about the man (Wikipedia) Simple Machines – as per videos
5	none		Students assigned to groups – up to teacher on how to put students into groups – no more than 4 but if necessary one or two groups of three – should be done before this first lesson
10	Duo tang and lined and blank paper for each duo tang	Skills Outcomes Performing and recording Communication and Teamwork Attitude Outcomes Mutual Respect Collaboration	Decide on how team will work together e.g. Leader – This person keeps the team on track and each meeting can be lead by a different person – needs to be decided each day Recorder – This person needs to write down what is discussed, decisions that are made and who is to do what each meeting Team members – active participants in discussions and to be able to summarize what has been done each meeting Decide on a team name – tell teacher and put on front of duo tang Put all notes in the duo tang Answer question – "How did our group work together and how we can improve? Collect duo tangs

Lesson 2 – Discussion of Simple Machines Lever, Inclined Plane and Wedge

Students should have some understanding of simple machines.
NOTE: Before this class prepare the Letter and Entry Forms for each student to take home. Photocopy form with Coordinator and Teacher's signatures before making all team forms.

Time In minutes	Materials Needed	Program of Studies	Activity
10	Duo tangs Overhead or chalkboard Computer and LCD projector	Outcomes for Science, Technology and Society (STS) and Knowledge #1 and #2	Discuss challenge and take questions Brainstorm ideas from the video and write on board, overhead
15	Worksheet Page 1	Work collaboratively on problems; and use appropriate language and formats to communicate ideas, procedures and results	In teams fill in first 2 columns of worksheet page 1
10	Large group discussion Team discussion Lined paper	Illustrate the development of science and technology by describing, comparing and interpreting mechanical devices that have been improved over time analyze a mechanical device, by: ..describing the overall function of the device ..describing the contribution of individual components or subsystems to the overall function of the device ..identifying components that operate as simple machines	Look at Internet sites as whole class showing Lever, Inclined Plane and Wedge Have whole class discussion around the machines just shown In teams discuss the Rube Goldberg device seen yesterday and which parts of the machine were Lever, Inclined Plane and Wedge Fill in column 3 with the actions that were Lever, Inclined Plane and Wedge In their duo tang answer this question – What did we learn today about simple machines – Lever, Inclined Plane and Wedge to help us design our device?

		identify the source of energy for some familiar mechanical devices identify linkages and power transmissions in a mechanical device, and describe their general function Skills Outcomes Initiating and Planning Performing and Recording Analyzing and Interpreting Communication and Teamwork Attitude Outcomes Interest in Science Mutual Respect Scientific Inquiry Collaboration	
5	Letter and Entry form home Agenda		have students take home the letter and entry form collect duo tangs – DO NOT LET THEM GO HOME

Lesson 3 – Discussion of Simple Machines – Pulley, Screw, Wheel and Axle and Gears

Students should have some understanding of simple machines and how they work. Start preliminary design

Time In minutes	Materials Needed	Program of Studies	Activity
10	Duo tangs Computer – LCD projector	Outcomes for Science, Technology and Society (STS) and Knowledge #1 #2 and #3	Collect Entry Form from all students Review discussion on machines from last lesson
15	Large group discussion Computer and LCD projector Worksheet 1	Illustrate the development of science and technology by describing, comparing and interpreting mechanical devices that have been improved over time analyze a mechanical device, by: ..describing the overall function of the device ..describing the contribution of individual components or subsystems to the overall function of the device ..identifying components that operate as simple machines identify the source of energy for some familiar mechanical devices identify linkages and power transmissions in a mechanical device, and describe their general function Skills Outcomes	Look at Internet sites as whole class showing Pulley, Screw, Wheel and Axle and Gears Have whole class discussion around the Pulley, screw, wheel and axle and gears In teams discuss the Rube Goldberg device seen yesterday and which parts of the machine were Pulley, Screw, Wheel and Axle and Gears Fill in column 3 on Worksheet page 1 with the actions that were Pulley, Screw, Wheel and Axle In their duo tang answer this question – What did we learn today about Pulleys, Screws, Wheel and Axles and Gears to help us design our ride?

		Initiating and Planning Performing and Recording Analyzing and Interpreting Communication and Teamwork Attitude Outcomes Interest in Science Mutual Respect Scientific Inquiry Collaboration	
15	Worksheet – page 2		In teams have a preliminary discussion about the Challenge and start to work on Worksheet page 2 Think how they might draw it. Each team member to draw another idea at home and bring to school next day
5	Letter and Entry form home – if not returned today Agenda		have students take home the letter collect duo tangs – DO NOT LET THEM GO HOME Each team member to draw one more rough drawing of an idea for the device

Lesson 4 – Discussion of Effort Force and Load Force

Understand Effort Force and Load Force and how they can help in the design of the Rube Goldberg device to extract the marble from the tube. What materials will be brought from home and what materials will school provide – tape, string, retort stand etc. – Let students know what they can use from school

Time In minutes	Materials Needed	Program of Studies	Activity
5	Duo tangs Worksheet Page 2		Teams get team duo tangs Explain what teams need to do Brainstorm some ideas of materials and machines they might use
25	Worksheet Page 2 Worksheet Page 3	Investigate and describe the transmission of force and energy between parts of a mechanical system analyze mechanical devices to determine speed ratios and force ratios build or modify a model mechanical system to provide for different turning ratios between a driving and driven shaft, or to achieve a given force ratio compare theoretical and actual values of force ratios, and propose explanations for discrepancies (e.g., identify frictional forces, and estimate their effect on efficiency) Skills Outcomes Initiating and Planning Performing and Recording	Students work in teams Continue working with worksheet 2 Look at each others drawings – put all ideas together Adjust drawing and decide on materials/machines that could be used for the device Make a list of materials/machines to bring to school for "Construction Day" Answer this question as a team: "What makes some material better than other for certain machines?"

		Analyzing and Interpreting Communication and Teamwork Attitude Outcomes Interest in Science Mutual Respect Scientific Inquiry Collaboration	
5	Agendas List materials needed		Put the materials they are responsible for in agenda Hand in duo tangs – DO NOT LET THESE GO HOME

Lesson 5 and 6 – Building the Device to "Extract Marble from the Tube"

Time In minutes	Materials Needed	Program of Studies	Activity
5	Duo tangs Worksheet Page 4 team Marble and tube given to each Rulers and tape		Explain what will happen for the day - go over worksheets Students to begin construction on their device Some will be trial and error but keeping measurement accurate will be critical
25	Worksheet Page 4	Investigate and describe the transmission of force and energy between parts of a mechanical system analyze mechanical devices to determine speed ratios and force ratios build or modify a model mechanical system to provide for different turning ratios between a driving and driven shaft, or to achieve a given	Decide who does what and keep jobs clearly defined Begin construction of the Rube Goldberg device Answer this question: "How are the simple machines working together to improve the device and if we need to make changes, why and what?" Who will do the Scientific Drawing – rough sketch can be started on Day 5 Good copy to be completed on Day 6 – (This is a critical part of the Challenge)

		force ratio compare theoretical and actual values of force ratios, and propose explanations for discrepancies (e.g., identify frictional forces, and estimate their effect on efficiency) Skills Outcomes Initiating and Planning Performing and Recording Analyzing and Interpreting Communication and Teamwork Attitude Outcomes Interest in Science Mutual Respect Scientific Inquiry Collaboration	
10	Agendas		Decide if other machines are needed and who will bring them to class the next day Put the measurements on the drawing so it can be easily set up and worked on the next day Collect Duo Tangs

Lesson 7 and 8 – Testing Device, Scientific Drawing and Presentation

Time In minutes	Materials Needed	Program of Studies	Activity
5	Duo tangs Worksheet Page 5a Measuring tapes Stop watches		Explain what will happen for the day - go over worksheets Remind teams to finish construction of the device Explain about test runs using marble
30	Worksheet Page 6 Score sheets	Investigate and describe the transmission of force and energy between parts of a mechanical system analyze mechanical devices to determine speed ratios and force ratios build or modify a model mechanical system to provide for different turning ratios between a driving and driven shaft, or to achieve a given force ratio compare theoretical and actual values of force ratios, and propose explanations for discrepancies (e.g., identify frictional forces, and estimate their effect on efficiency) Skills Outcomes Initiating and Planning Performing and Recording Analyzing and Interpreting Communication and Teamwork	Finish the device Do test runs Time length it take to complete extraction of marble Finish Scientific Drawing – blank paper, sharp pencil and ruler Check score sheets to see where they can 'gain marks' Each team member to decide on what their part in the presentation will be Brainstorm ideas for presentation Discuss how to add to presentation, drawing and device – consult Score Sheets Question: "What do we need to add, change or delete and why?"

		Attitude Outcomes Interest in Science Mutual Respect Scientific Inquiry Collaboration	
5	Agenda		Homework – work on their part of the presentation – 15 seconds maximum per student Finish drawing if not done

Lesson 9 and 10 – Scanning, Filming and Uploading

Time In minutes	Materials Needed	Program of Studies	Activity
5	Duo tangs Measuring tapes Stop watches Camera		Explain what will happen for the day - go over worksheets Remind teams to finish construction on their device Explain about test runs extracting marble from tube
30	Score sheets Computers for Uploading	Analyze the social and environmental contexts of science and technology, as they apply to the development of mechanical devices evaluate the design and function of a mechanical device in relation to its efficiency and effectiveness, and identify its impacts on humans and the environment develop and apply a set of criteria for evaluating a given mechanical device, and defend those criteria in terms of relevance to social and environmental needs	Review Score Sheets Do test runs Measure time it takes to complete extraction of marble – no more that 1 minute – add to drawing Scan drawing and save in file – name it "Team Name drawing" Practice Presentation – if ready use camera to film – 1 minute On 2nd day – what could they improve upon in the presentation or Scientific Drawing Upload presentation, the device photo and scanned drawing Question: "If we could start again, what would we do differently and why?"

		illustrate how technological development is influenced by advances in science, and by changes in society and the environment Skills Outcomes Initiating and Planning Performing and Recording Analyzing and Interpreting Communication and Teamwork Attitude Outcomes Interest in Science Mutual Respect Scientific Inquiry Collaboration Safety	
5	Agendas		What needs to be done for homework – last day