

Transformation 2013 Design Challenge Planning Form Guide

Design Challenge Title: Work and Machines—Rube Goldberg Style

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School: Harlandale High School

Subject: Conservation Laws: Work-Energy, Energy Transformations

Abstract: Students will build a Rube Goldberg compound machine and analyze the different types of energy transformations exhibited by their machine.

MEETING THE NEEDS
OF STEM EDUCATION
THROUGH DESIGN CHALLENGES

Begin with the End in Mind

The theme or “big ideas” for this design challenge:

Students should be able to describe different types of energy and apply this knowledge to everyday situations that involve energy transformations. Students will analyze the connection between the Work-Energy theorem and the Law of Conservation of Energy.

TEKS/SEs that students will learn in the design challenge:

(5) Science concepts. The student knows that changes occur within a physical system and recognizes that energy and momentum are conserved. The student is expected to:

(A) interpret evidence for the work-energy theorem;

(B) observe and describe examples of kinetic and potential energy and their transformations;

(D) demonstrate the conservation of energy

Key performance indicators students will develop in this design challenge:

Develop vocabulary (kinetic energy, potential energy, gravitational potential energy, chemical potential energy, elastic potential energy, mechanical energy, solar/radiant energy, thermal energy, electrical energy, work, power, mechanical advantage, efficiency, simple machine, compound machine, machine, lever, screw, pulley, inclined plane, wedge, wheel and axle), describe the Law of Conservation of Energy and apparent “losses” of energy, describe the work-energy theorem, calculate work, calculate mechanical advantage, calculate efficiency, calculate power, integrate knowledge of machines and energy transformations to design and build a Rube Goldberg machine

21st century skills that students will practice in this design challenge:

www.21stcenturyskills.org

Critical thinking, problem solving, written and oral communication, collaboration

STEM career connections and real world applications of content learned in this design challenge:

Careers: Mechanical engineer

Connections: We are surrounded by machines, both simple and complex, and energy transformations in our everyday lives.

The Design Challenge

While volunteering at the hospital, you run into a friend that you haven't seen since elementary school. Apparently she had a bad spill trying to do some crazy tricks on her skateboard. She is healing well, but is in a full body cast. Because of her physical constraints, she is having trouble completing even the smallest tasks—flipping the pages of a magazine, cutting her own food—and is going stir crazy because of it. A Rube Goldberg machine would be the perfect thing to entertain her and take care of one of the simple tasks that she can't do herself—and it's up to you to make it.

Map the Design Challenge

Performance Indicators	Already Learned	Taught before the project	Taught during the project
1. Vocabulary development (kinetic energy, potential energy, gravitational potential energy, chemical potential energy, elastic potential energy, mechanical energy, solar/radiant energy, thermal energy, electrical energy, work, power, mechanical advantage, efficiency, simple machine, compound machine, machine, lever, screw, pulley, inclined plane, wedge, wheel and axle)	X	X	X
2. Solving word problems using formulas for work, power, efficiency, mechanical advantage, and the concept of conservation of energy		X	X
3. Describe the Law of Conservation of Energy and apparent “losses” of energy		X	X
4. Describe the work-energy theorem		X	X
5. Design and build a Rube Goldberg machine		X	X

Team-Building Activity

It is important that teachers provide team-building activities for students to help build the 21st Century Skills that are necessary for success in the workforce. Team-building helps establish and develop a greater sense of cooperation and trust among team members, helps students adapt to new group requirements so that they can get along well in a new group, serves to bring out the strengths of the individuals, helps identify roles when working together, and leads to effective collaboration and communication among team members so that they function as an efficient, productive group. Our students are often not taught how to work in groups, yet we assume that they automatically know how. Use team-building activities with your students so that you can see the benefits which include improvement in planning skills, problem solving skills, decision making skills, time management skills, personal confidence, and motivation and morale.

Radioactive Swamp

The scenario: You and your team have just crash landed on an alien planet. One of your team members was injured during the crash and can no longer walk. With your current supplies you have no hope of fixing your ship, so you decide to search the alien planet. Your ship, however, is surrounded by a radioactive swamp on all sides.

Objective: Get all 4 team members across the 3m radioactive swamp using only 4 hoverboards (1 ft x 1ft pieces of carpet).

Rules:

1. Hoverboards can not be left unattended in the swamp.
2. All team members must make it to the other side. The injured team member can not walk.
3. Any body parts that touch the swamp become injured, and can no longer be used OR the team must start over.

It is best to do this activity outside in a grassy area (like the football field).

Processing questions:

1. What was the most important factor in your team's success?
2. Who in your team showed leadership? Why?
3. How did the injured person feel about their contributions to the team?
4. In what ways could your team improve?

5E Lesson Plan

Design Challenge Title: *Work and Machines—Rube Goldberg Style*

TEKS/TAKS objectives: §112.47. Physics 5ABD

Engage Activity

Activity 1: Conservation of Energy

Nose Crusher

Mount a bowling ball pendulum from the ceiling. The path of the pendulum should be free of obstacles. Stand with back against the wall and bowling ball held up to nose. Release the ball without pushing it, and the ball will come back up to the nose (almost to release point) without hitting your nose. To avoid getting hit, do not lean forward after release or push the ball when releasing it.

A more dramatic version of this demonstration involves crushing a watermelon by putting the watermelon in the place of the demonstrators head, and giving the bowling ball a push when releasing it. Afterwards, the demonstrator (or a brave volunteer) completes the second half of the demonstration as outlined above. Use the demonstration to discuss how energy is conserved because it is converted from potential energy to kinetic energy. The ball seems to lose energy during subsequent swings because of friction and air resistance, which convert energy to heat.

For additional information:

http://www.ap.smu.ca/demos/navigation/navigation_frames.html

click on “The Nose Crusher” (left sidebar)

Have students reflect on the demonstration in their journals.

Continue to Explore Activity 1 after this demonstration.

Activity 2: Work-Energy Theorem

www.brainpop.com

“Work” science video.

Have students either write down 5 things they learned/found interesting from the video, or have students complete quiz after video.

Continue to Explore Activity 2 after the video.

Activity 3: Energy transformations

Gummy bear+ Potassium Chlorate (or Sodium Chlorate)

Chemical energy → thermal energy + radiant energy

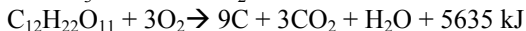
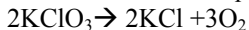
Heat a small amount of potassium chlorate in a test tube mounted with a test tube clamp on a ring stand.

When the potassium chlorate is liquefied, drop in a gummy bear (or any piece of candy that will fit into the test tube). The gummy bear will react with the potassium chlorate to produce heat, light, CO₂ and H₂O.

Link this process of breaking down the glucose (sucrose in gummy bear = fructose + glucose) into energy, CO₂, and H₂O to the process of cellular respiration in living things. The major difference being that the energy produced in cellular respiration is ATP.

You can also review balancing equations.

Balanced chemical equations:



Safety notes: You should be wearing goggles and a lab coat/apron. Students should be wearing goggles or separated from the experiment with a blast shield around the experiment set up.

Combustibles should be removed from experiment area.

Clean up: After test tube has cooled, soak it in water for 10 minutes, scrub, and rinse. Chemicals are safe to go down the drain.

To see a video of this experiment go to:

<http://video.google.com/videoplay?docid=7433492777550198070>

Have students reflect on the demonstration in their journals.

Introduce Design Challenge:

While volunteering at the hospital, you run into a friend that you haven't seen since elementary school. Apparently she had a bad spill trying to do some crazy tricks on her skateboard. She is healing well, but is in a full body cast. Because of her physical constraints, she is having trouble completing even the smallest tasks—flipping the pages of a magazine, cutting her own food—and is going stir crazy because of it. A Rube Goldberg machine would be the perfect thing to entertain her and take care of one of the simple tasks that she can't do herself—and it's up to you to make it.

Students should work in groups of 3-4 to complete the design challenge. Students should begin the “Work and Machines—Rube Goldberg Style: Design and Planning”. Students should be provided with project rubric and analysis expectations.

Continue to Explore Activity 3.

Engage Activity Products and Artifacts

Radioactive Swamp: Answers to processing questions

Activity 1: Journal Reflection

Activity 2: Brainpop notes or quiz results

Activity 3: Journal Reflection

Engage Activity Materials/Equipment

Radioactive swamp: large open space, meter sticks, 4 1ft x1ft pieces of carpet per group **Activity 1:** bowling ball pendulum ceiling mounted, watermelon (dramatic version only), **Activity 2:** computer with internet access, projector, access to www.brainpop.com, **Activity 3:** Potassium or Sodium chlorate, gummy bear, large test tube, test tube clamp, ring stand, Bunsen burner or propane torch, goggles, blast shield, apron, “Work and Machines—Rube Goldberg Style: Design and Planning”, project rubric, project analysis expectations

Engage Activity Resources

http://www.ap.smu.ca/demos/navigation/navigation_frames.html click on “Nose Crusher”

www.brainpop.com “Work” video in science category

<http://video.google.com/videoplay?docid=7433492777550198070> video demonstration of Activity 3

Examples of Rube Goldberg Machines <http://mousetrapcontraptions.com/cool-machines-3.html>

<http://www.basd.net/staff/kharman/Projects/goldberg%20pics.htm>

Video <http://video.google.com/videoplay?docid=-2367646121273499414>

Explore Activity

Activity 1: Conservation of Energy

Design a Roller Coaster (see handout)

Students will use pipe insulation, masking tape, and wooden dowels to construct a roller coaster with at least 1 big hill, one loop, and one turn that a golf ball can navigate successfully. Students can attach their coasters to walls, tables, or chairs for additional support.

After successful construction, students will find the lowest part of their roller coaster and set up two photogates to measure the average velocity of the ball at that point over five trials. Students will use the average velocity to calculate the kinetic energy of the ball. Students will calculate the potential energy of the ball at its highest point. Students will compare these values and analyze their results. (see handout)

Have students work in groups of two or three.

Follow this activity with Explain Activity 1.

Activity 2: Work-Energy Theorem

Warm Up: Generate ideas about what “work” means. Pick up a heavy box and carry it across the room. Do they think you did work? Explain that according to physics, you only did work when lifting the box, not carrying it.

Work, Energy, and Machines Stations (see handout)

Place the following descriptors at the individual stations

Station 1:

Do work on the textbook at this station. Describe the work you did.

Station 2:

The roller coaster is set up to measure the average velocity of the golf ball through a certain section of the coaster. 1. Calculate the kinetic energy of the golf ball. 2. How much work does the force of gravity do on the ball?

Station 3:

At this station there are three objects: a screw, a jar lid, and a plastic bottle cap. These three objects are examples of a simple machine called a screw. 1. What are two features that all screws have in common? 2. What is another example? 3. How does this object decrease input force or increase distance to make work easier?

Station 4:

At this station there are three objects: a plastic knife, scissors, and a thumbtack. These objects are examples of a simple machine called a wedge. 1. What are two features that all wedges have in common? 2. What is another example? 3. How does this object decrease input force or increase distance to make work easier?

Station 5:

At this station there are three objects: a toy car, clock gears, and a round door knob. These objects are all examples of a simple machine called a wheel and axle. 1. What are two features that all wheel and axles have in common? 2. What is another example? 3. How does this object decrease input force or increase distance to make work easier?

Station 6:

At this station there are three objects: a light switch, a bottle opener, and a three hole punch. These objects are all examples of levers. 1. What are two features of a lever? 2. What is another example? 3. How does this object decrease input force or increase distance to make work easier?

Station 7:

At this station there are two objects: a set of blinds, and a retractable dog leash. These are both examples of pulleys. 1. What are two features of a pulley? 2. What is another example? 3. How does this object decrease input force or increase distance to make work easier?

Station 8:

At this station there are two objects: a picture of a ramp leading into a building, and a toy slide. These objects are examples of inclined planes. 1. What are two features of an inclined plane? 2. What is another example? 3. How does this object decrease input force or increase distance to make work easier?

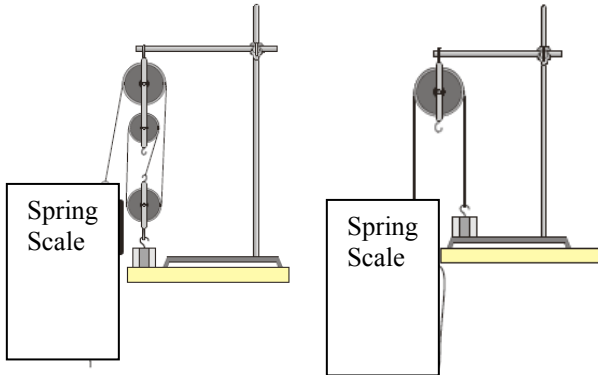
Station 9:

At this station use the apple corer/peeler to do work on the apple. This is an example of a compound machine. 1. What simple machines make up this compound machine? 2. How does this object decrease input force or increase distance to make work easier?

Station 10:

Pulley System A

Pulley system B



A pulley's mechanical advantage can be determined by counting the number of supporting strands of the pulley. Determine which of these pulley systems has more of a mechanical advantage by counting the supporting strands of the pulley. 1. Record the # of supporting strings. 2. Now, check your answer to #1 by testing the force required to lift the weight using the spring scale.

Notes: For station two, set up photogates in a manner similar to how it was done in Explore Activity 1. For stations 3-8, use objects that you have. If you don't have the objects described here, switch them out or use a picture of the object. Set up station 7 near a window if you have windows with blinds, and station 6 near the light switch or the door (another lever example). For station 9: buy small apples, and provide one for each group. For station 10, set up two pulley systems as shown in the picture.

Have students complete stations in groups of three.

Follow this activity with Explain Activity 2.

Activity 3: Energy Transformations

Energy Transformation Stations (see handout)

Warm up: Generate types of energy with students and write them on the board for the students to refer to during the following activity. (kinetic-thermal, radiant, mechanical, electrical; potential-gravitational, elastic, chemical, nuclear)

Place the following descriptors at the individual stations.

Station 1

At this station there is a food item. (a) Sitting on the table, does that piece of food have energy? (b) Why do you eat food?

Station 2

At this station there is a rubber band. (a) What would happen if you stretched the rubber band and then let it go? **DO NOT AIM THE RUBBER BAND AT ANYONE OR SHOOT ANYONE WITH IT.** (b) What type of energy transformation do you think this is?

Station 3

At this station there is a rubber ball. Hold the ball above the table. (a) What type of energy does the ball have now? (b) When you drop the ball what kind of energy transformation takes place?

Station 4

At this station there is a light bulb and a radiometer. (a) What happens to the radiometer when you turn on the light bulb? (b) What type of energy transformation do you think this is?

Station 5

At this station you will find a hand generator, and a light bulb.

Connect the hand generator to the light bulb and turn the handle. (a) What happens? (b) What type of energy transformation is this?

Station 6

At this station you will find a hand generator and a battery. Connect the generator to the battery and hold the generator by the blue portion. (a) What happens? (b) What type of energy transformation is this?

Station 7

The picture at this station shows a racecar speeding around the track. What kind of energy transformation is happening here?

Station 8

At this station you will find a lemon attached to two alligator clips. There is also a voltmeter at the station. A voltmeter is a device that measures conduction of electricity. Attach the green alligator clip to the negative black node and the red clip to the red 5 node. (a) What do you notice on the voltmeter? (b) What type of energy transformation is this?

Note: see resources for set up

Station 9

At this station you will find a solar calculator. Cover the small solar panels tightly with your index finger. (a) What happens? (b) What type of energy transformation does the calculator use?

Station 10

The picture at this station shows a roller coaster rolling down a hill. What energy transformation happens when the roller coaster begins at the top of the hill and then starts rolling down?

Have students complete stations in groups of three.

Continue to Explain Activity 3.

Explore Activity Products and Artifacts

Activity 1: Roller Coaster Design and Analysis sheet

Activity 2: Work, Energy, and Machines Handout

Activity 3: Energy Transformations Handout

Explore Activity Materials/Equipment

Activity 1: Pipe insulation (cut in half, 2-3m per group), masking tape, wooden dowels (2-3 per group), PASCO photogates (2 per group), Vernier ULI interface, golf balls (1 per group) Roller Coaster Design and Analysis sheet **Activity 2:** textbook, one roller coaster from Activity 1 with photogates, screw, jar lid, plastic bottle cap, plastic knife, scissors, thumbtack, toy car, clock gears, round door knob, light switch, bottle opener, three hole punch, blinds, retractable leash, picture of ramp, toy slide, apple corer/peeler, apples (1 per group), 4 pulleys (see picture), string, two ring stands, two hanging weights (equal mass), 2 spring scales, Work, Energy, and Machines Handout **Activity 3:** can of food, rubber band, rubber ball, light bulb with stand, radiometer, 2 hand generators, 1 9V battery individual Christmas lights or small light bulb in ceramic holder, picture of racecar on track, lemon, voltmeter, 2 alligator clips, galvanized nail, penny, solar calculator, picture of roller coaster or roller coaster set up from activity 1, Energy Transformations Handout

Explore Activity Resources

Lemon battery http://hilaroad.com/camp/projects/lemon/lemon_battery.html

Explain Activity

Students will take Cornell notes for parts 1 and 2 of the PowerPoint presentation. See resources section for a website that explains how to take Cornell notes.

Students will revise their “Energy Transformations” handout during Part 3 of the presentation.

After Part 1 of presentation, do Engage Activity 2.

After Part 2 of presentation, assign the four practice problems at the end of the presentation for homework. Continue with Engage Activity 3.

After Part 3 of presentation, move on to Elaborate.

Explain Activity Products and Artifacts

Cornell notes for Parts 1 and 2 of presentation

Homework Problems assigned at the end of Part 2

Revised “Energy Transformations” handout

Explain Activity Materials/Equipment

PowerPoint presentation “Energy: Conservation, Work, and Transformations”, computer, projector, “Energy Transformations” handout

Explain Activity Resources

PowerPoint presentation “Energy: Conservation, Work, and Transformations”

Instructions for Cornell notes <http://coe.jmu.edu/learningtoolbox/cornellnotes.html>

Additional word problems <http://zebu.uoregon.edu/~probs/mech/work.html>

Elaborate Activity

Students will plan and build Rube Goldberg machine for the design challenge. Students should work in Groups of 3-4.

Students should expect to gather materials from around their homes/school that will fit their design.

The machine should have at least ten steps, and should include at least one example of each of the six simple machines.

Students need to see the Rubric before they begin.

Students need to be aware that they will be expected to discuss how their machine relates to $W = Fd$, the Work-Energy Theorem, the Law of Conservation of Energy, energy transformations, and efficiency.

Elaborate Activity Products and Artifacts

Design and Planning Sheet for “Work and Machines—Rube Goldberg Style”

Rube Goldberg machine

Elaborate Activity Materials/Equipment

Design and Planning Sheet for “Work and Machines—Rube Goldberg Style”, tools to aid in machine construction (hammer, nails, glu gun, glue sticks, string, etc)

Elaborate Activity Resources

Examples of Rube Goldberg Machines <http://mousetrapcontraptions.com/cool-machines-3.html>

<http://www.basd.net/staff/kharman/Projects/goldberg%20pics.htm>

Video <http://video.google.com/videoplay?docid=-2367646121273499414>

Evaluate Activity

It is a good idea to give students an additional 1-2 weeks outside of class time to work on this project.

Rube Goldberg machines will be evaluated using the “Work and Machines—Rube Goldberg Style: Machine Rubric”

Students will write an analysis of their machine that includes how their machine relates to $W = Fd$, the Work-Energy Theorem, the Law of Conservation of Energy, energy transformations, and efficiency.

Students can also present their machine and analysis to the class.

Evaluate Activity Products and Artifacts

Machine Rubric Evaluation

Student Analysis of Rube Goldberg machine

Evaluate Activity Materials/Equipment

Student machines, Rubric for Scoring Machines, Student Analysis Expectation sheet

Evaluate Activity Resources

Rubric for Scoring Machines, Student Analysis Expectation sheet

Roller Coaster-Design and Analysis

Objective: To relate potential and kinetic energy calculations to the Law of Conservation of Energy.

Materials:

Pipe insulation (cut in half, 2-3m)
 2 PASCO photogates

Masking tape Wooden dowels
 Vernier ULI interface

Procedure:

1. Design and build your roller coaster. It must have at least 1 large hill, one loop, and one turn. The golf ball must be able to navigate the entire track without falling off.
2. Use the two gate timing mode from Logger Pro. Set up the photogates at the lowest point on the coaster.
3. Take the mass of the golf ball. Record.
4. Measure the diameter of the golf ball and enter it in the experimental set up on LoggerPro.
5. Release the ball from the same point each time. Do 5 trials. Record the average velocity.
6. Use the average velocity to calculate kinetic energy ($KE = 0.5mv^2$).
7. Calculate the potential energy at the release point ($PE = mgh$)

Data:

Diameter of ball: _____ Mass of Ball: _____ Height of release point: _____

Draw a data table appropriate for recording the velocities for the 5 trials:

$KE_{\text{lowest point}} =$ _____

$PE_{\text{release point}} =$ _____

Analysis:

1. Compare your calculated values for kinetic energy of the ball at its lowest point and the potential energy of the ball at its release point.

Work, Energy, and Machines

Background Information:

Work in physics is calculated by multiplying the magnitude of the force applied to an object with the displacement of that object in a direction parallel with the applied force. This is summarized in the formula $W=Fd$. Work is measured in Joules, the same unit used to measure different types of energy. The work-energy theorem states that the net work done on an object is equal to its change in kinetic energy or $W= \Delta KE = KE_f - KE_i$. Machines are used to make work easier. Mechanical advantage is a number that describes how much the effort force (force put into machine) is multiplied by using the machine. No machine is 100% efficient. Energy is released as heat because of friction between moving parts.

Station	Description	Picture	Observations/Analysis
1			
2			1. 2.
3			1. 2. 3.
4			1. 2. 3.

Station	Description	Picture	Observations/Analysis
5			1. 2. 3.
6			1. 2. 3.
7			1. 2. 3.
8			1. 2. 3.

Energy Transformations

Station	Description	Picture	Observations/Analysis
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

Work and Machines—Rube Goldberg Style: Design and Planning

1. Research Rube Goldberg machines online.
2. What is the task you want your machine to accomplish? _____
3. Your machine must have a minimum of at least ten steps, and must include a representative of each of the simple machines. Sketch your design below.

4. How are you incorporating each of the six simple machines in your design?

- a. Lever _____
- b. Wedge _____
- c. Wheel and Axle _____
- d. Pulley _____
- e. Screw _____
- f. Inclined Plane _____

5. List the steps of your machine below (10 minimum).

6. There should be a minimum of 5 energy transformations. Describe the energy transformations:

7. Describe how this machine relates to $W=Fd$, the Work-Energy Theorem, and the Law of Conservation of Energy.

8. How would you go about calculating the efficiency of your machine?

Plan the Assessment

Engage Artifact(s)/Product(s): <i>“Radioactive Swamp” processing questions, “Nose Crusher” journal entry, “Work” Brainpop quiz results or notes, “Energy Transformation” journal entry</i>
Explore Artifact(s)/Product(s): <i>“Roller Coaster Design and Analysis” lab handout, “Energy, Work, and Machines” stations handout, “Energy Transformations” stations handout</i>
Explain Artifact(s)/Product(s): <i>Cornell notes for Part 1, Cornell notes for Part 2, Homework from Part 2, Revised “Energy Transformations” stations handout</i>
Elaborate Artifact(s)/Product(s): <i>Design and Planning sheet for “Work and Machines: Rube Goldberg Style” Rube Goldberg machine</i>
Evaluate Artifact(s)/Product(s): <i>Analysis of Rube Goldberg Machine</i>

Rubrics

Rubric: Rube Goldberg Machine

	1	2	3	4
Number of steps	Process is at least 2 steps.	Process is at least 5 steps	Process is at least 8 steps	Process is ten steps or more
Number of energy transformations	Machine exhibits at least 1 energy transformation	Machine exhibits at least 2 energy transformations	Machine exhibits at least 4 energy transformations	Machine exhibits 5 or more energy transformations
Simple machines used	Machine uses at least 1 simple machine	Machine uses at least 3 simple machines	Machine uses at least 4 simple machines	Machine uses all 6 simple machines
Reliable design	Machine is not sturdy, parts fall off/apart	Machine is sturdy, but does not complete task	Machine is sturdy and can complete the task once	Machine is sturdy and complete the task more than once

Total Points Earned _____/16

Work and Machines—Rube Goldberg Style: Analysis Expectations

Write an analysis of your machine that includes how the machine relates to $W = Fd$, the Work-Energy Theorem, the Law of Conservation of Energy, energy transformations, and efficiency.

Total Points Possible: 15

Energy Transformations: Identify the transformation and describe how the transformation effects the overall process (1 point each, 5 total points possible)

$W = fd$: Explain this equation (1 pt). Relate it to the work done by your machine (1 pt)

Work-Energy Theorem: Explain this theorem (1 pt). Use the theorem to explain how you could calculate the work done by your machine (1 pt).

Law of Conservation of Energy: Explain this law (1 pt). Explain the forces at work in your machine that account for apparent “losses” of energy (1 pt).

Efficiency: Explain how you could calculate the efficiency of your machine (1 pt) Answer the following question: Is it possible for your machine to be 100% efficient? Explain your answer (1 pt).

Reflection: What modifications would you make to the machine to improve its performance (1 pt)? Describe the most important lesson learned while completing this project (1 pt).

Story Board

	Day 1	Day 2	Day 3	Day 4	Day 5
Week 1 Activities (based on 50 minute class periods)	<ul style="list-style-type: none"> Radioactive Swamp 	<ul style="list-style-type: none"> Engage Activity 1: "Nose Crusher" Journal Entry Preview Explore Activity 1: Roller Coaster design and Analysis. Group students and have them sketch design 	<ul style="list-style-type: none"> Explore Activity 1: "Roller Coaster Design and Analysis". Give students 20 minutes to build their design. Use remaining class time to take measurements and answer analysis questions 	<ul style="list-style-type: none"> Explain Part 1: Students take Cornell Notes Engage 2: Brainpop "Work" 	<ul style="list-style-type: none"> Explore Activity 2: "Work, Energy, and Machines Stations"
	Day 6	Day 7	Day 8	Day 9	Day 10
Week 2 Activities (based on 50 minute class periods)	<ul style="list-style-type: none"> Explain Part 2: Students take Cornell notes Practice Problems for homework 	<ul style="list-style-type: none"> Go over homework, Review Cornell notes in student groups Engage 3: Energy Transformations Introduce Design Challenge: Group and begin planning 	<ul style="list-style-type: none"> Explore 3: Energy Transformations Stations 	<ul style="list-style-type: none"> Explain 3: Students revise previous day's lab handout Continue planning for design challenge Homework: Gather supplies for Rube Goldberg machine 	<ul style="list-style-type: none"> Group time to plan/construct Rube Goldberg machine Students work on project over weekend Note: You may want to start the next unit here and give students 1-2 weeks outside of class to complete the project
	Day 11	Day 12	Day 13	Day 14	Day 15
Week 3 Activities (based on 50 minute class periods)	<ul style="list-style-type: none"> Student Presentations of Machines Student analysis of machines due 				