LATHROP ENGINEERING

Name:

UNIT 8: SIMPLE MACHINES

Introduction to Engineering & Robotics Unit Due Date: **February 21, 2020**

Welcome to the eighth unit of *Introduction to Engineering & Robotics*! This unit is all about basic physics, simple machines, and complex machines. Engineers need to know all about machines of different kinds, and here we will look at six machines that give engineers a mechanical and mathematical advantage when trying to get work done! In the end, the expectation is that you learn the following:

- What the six simple machines are: levers, pulleys, inclined planes, wedges, screws, and wheels & axles
- How the six simple machines create mathematical advantages
- How simple machines can be combined to make complex machines
- How the complex machines in our engineering lab use simple machines
- How to create your own complex machines within the criteria and constraints of a design breif

As we move through this unit, you are responsible for making adequate progress through the assignments, and for being done by the Unit Due Date (**February 21, 2020**). Our unit is broken up into three main parts:

Part 1: **Simple Machines** *(30 pts) Approx. 3 days*		
The first topic of this unit is the study of the six simple machines. You'll start by watching four videos that summarize how the 6 simple machines work. Once you have a good understanding for what they are, we'll review some mathematics as it applies to the simple machines. Finally, you'll complete a simple machine scavenger hunt in our engineering lab!		Simple Machines Notes
		Simple Machines Math Assign.
		Simple Machines Scavenger Hunt
		Check-off from Mr. Benshoof

Part 2: **Complex Machines** *(40 pts) Approx. 2 days*		
The second part of our unit is about the complex machines. A complex machine is a combination of multiple simple machines. Cars, drills, computers, and phones are all examples of complex machines. In this part of the unit you'll watch some videos of cool complex machines and take notes on how they work. Then, you'll complete a short assignment. Finally, you'll make a careful diagram of one of the large complex machines in our lab and identify the simple machines that make it work.		Complex Machine Notes
		Complex Machine Assignment
		Complex Machine Diagram
		Take Unit 8 Quiz
		Check-off From Mr. Benshoof

Part 3: **Rube Goldberg Challenge** *(20 pts) Approx. 3 days*		
The final step is to put your knowledge of simple machines to the test! Here, you and a partner will have to build a small Rube Goldberg Machine that can keep a marble in motion and off the table for exactly 11 seconds. Your machine will need to use all 6 simple machines and be precise within ± 0.5 seconds. This will require a lot of planning and troubleshooting as you get it nailed down!		Brainstorm, Plan, Design
		Prototype Machine
		Test & Evaluate Machine
		Check-off from Mr. Benshoof
Achievement: Get your Rube Goldberg Challenge Machine to work 5 times in a row.		

(30 pts) Approx. 3 days

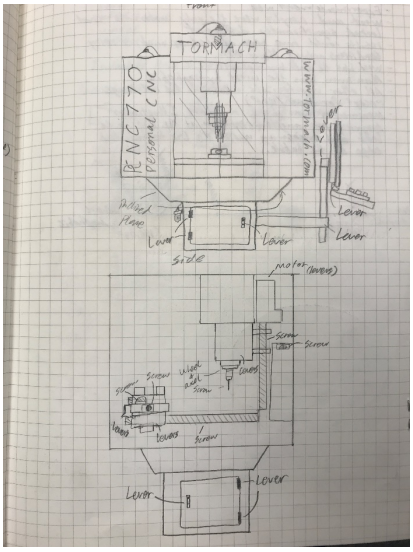
To begin our conversation about types of machines and the mechanics of different types of machines,we have to start with the 6 simple machines. Whether you're studying physics or engineering, the concepts behind the 6 simple machines are essential to understand. In the first part of our unit here, your job will be to learn about the 6 simple machines, do some mathematics, and then complete a scavenger hunt in our lab to find simple machines in action!

1. **Notes:** Start by watching the 4 Simple Machine videos linked on the website. As you watch the videos – each of them are pretty long – be sure to take notes about how the simple machine works. Your notes should also include any details or drawings that help explain some of the mathematical concepts behind those machines.
2. Take a FULL 2 PAGES of notes on the 6 simple machines. There is a nice one-page summary of each of the simple machines in addition to videos on the topics. The first video discusses the *inclined plane, wedge,* and *screw* all in one video. The other videos are clearly labeled as *levers*, *wheels & axles,* and *pulleys*. Make sure that your notes cover all 6 simple machines.
3. **Simple Machine Math Assignment:** Get the *Simple Machines Math Assignment* from Mr. Benshoof. Use the equations given on that sheet to calculate all the needed forces. Think about how an engineering might use these mathematical ideas to build better machines!
4. **Scavenger Hunt:** Title a new page in your engineering notebook "Simple Machine Scavenger Hunt". Your scavenger hunt is to find 6 distinct examples of each of the 6 simple machines in our lab. You might find wedges at work in the robotics room…. Or maybe inclined planes in the Makerspace. Take some time to wander the whole engineering lab and record the things you find in your engineering notebook. As you record them, keep your lists organized so Mr. Benshoof can tell which items fall into which categories.

Part 1: Tasks	*10-8 points*	*7-4 points*	*3-0 points*
Simple Machine Notes	+ You took 2 full pages of notes on the 6 simple machines + Your notes include details on ALL 6 of the simple machines + Your notes make it clear you watched the videos	- Your notes are missing one of the simple machines. - Your notes are lacking details from the videos	- Your notes are missing more than one simple machine
Simple Machine Math	+ You completed the *Simple Machines Math Assignment* + You showed your work on the entire assignment + You checked your work with the answer key	- You did not complete the entire assignment	- You were missing large parts of the assignment
Scavenger Hunt	+ You found 6 examples of every simple machine + Your examples are listed clearly in your engineering notebook + Your lists are organized in an understandable way	- You have fewer than 6 examples for each simple machine - Your examples are poorly organized	- You have fewer than 4 examples for each simple machine - Your examples are missing completely (0 pts)

(40 pts) Approx. 2 days

The second part of this unit takes the ideas of simple machines and adds them together into larger complex machines. For the purpose of our work, a "complex machine" is a machine made up of many simple machine components. Most of our machines in the lab are complex machines. The 3D printer, laser engraver, CNC mill, band saws, and even the T-Shirt press are all combinations of many smaller simple machines. In this part of the unit, you'll be asked to look at different complex machines and identify the simple machines contained within them. Look carefully and think about how you might use other simple machines in complex machines of your own!



1. **Complex Machine Notes:** Start by watching all three complex machine vides: *Gears*, *4-Bar Linkage*, and the *Tree Transplanter* videos. Take a full page of notes on the ideas presented here. In addition, draw a diagram of the 4-bar linkage and the tree transplanter. Identify as many simple machines in those complex machines as you can.
2. **Complex Machine Diagram:** Next, make a nice careful drawing of a complex machine here in the lab! Pick from one of the machines listed below, and then use your engineering notebook to make a nice careful diagram of the working parts in it.

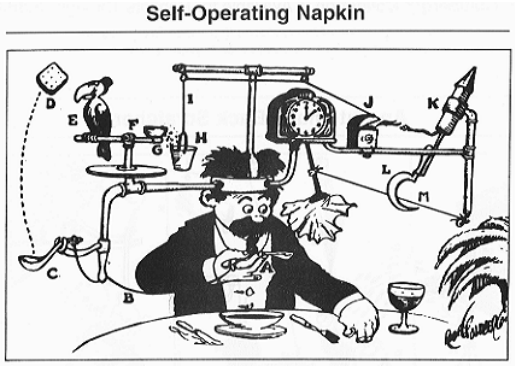
3D Printer	*Laser*	**CNC Router**
Tormach	**Drill Press**	*Band Saw*

   On your diagram, label as many simple machines as you can. One example is given to the right.
3. **Complex Machine Assignment:** Talk to Mr. Benshoof about the complex machines assignment, and complete it!
4. **Unit 8 Quiz:** Take the Unit 8 Quiz by the due date!

Part 2: Tasks	*10-8 points*	*7-5 points*	*4-0 points*
Complex Machine Notes	+ You took a full page of notes on the different complex machine videos + Your notes include pictures of those machines and details about which simple machines make them possible!	- Your notes are missing important elements - Your notes do not include pictures of the complex machines	- Your notes are missing - Your notes are severely lacking
Complex Machine Assignment	+ You completed the Complex Machines Assignment	- You completed most of the Complex Machines Assignment	- You did not complete the complex machines assignment
Complex Machine Diagram	+ You made a nice careful diagram of a complex machine here in the lab. + Your drawing identifies as many simple machines as you can! + Your diagram identifies all 6 simple machines	- Your diagram is missing elements - You did not label all the simple machines - Your diagram is quick or sloppy	- Your diagram is missing - Your labels are missing
Take Unit 8 Quiz	+ You took the Unit 8 Quiz on the website by the Quiz Due Date + Grade is based on number correct	N/A	(0 pts) You did not take the Unit 8 Quiz

(20 pts) Approx. 3 days

The final part of our unit asks you to work with a partner to build a functioning Rube Goldberg device. A Rube Goldberg device – named after an inventor who liked to draw cartoon contraptions that did simple things – is a complex machine that uses multiple simple machines to accomplish very simple tasks. In this case, you'll need to build a Rube Goldberg device that can keep a marble moving for *exactly 9 seconds*.



Below is the Design Brief for the Rube Goldberg Challenge:

PROBLEM STATEMENT: Create a Rube Goldberg machine that can keep a marble *in motion* for exactly 6 seconds. The machine is considered successful if it keeps the marble moving for between 5.9 and 6.1 seconds in 3 out of 5 consecutive attempts.

DEADLINE: Your machine must be complete ***and tested*** by the end of class on ***Friday, February 21***

CRITERIA: Your machine must meet the following criteria:

- From when you start the machine/marble in motion until the marble stops moving must be as close to 6 seconds as possible.
- Your machine needs to work successfully in 3 out of 5 trials.

CONSTRAINTS: Your machine must fit within the following constraints:

- The machine must fit on one of the yellow foam trays
- The machine must be made out of a single sheet of poster board, string, and hot-glue
- The machine must use AT LEAST 3 simple machines
- The machine must have a clear stopping point for the marble

AUDIENCE: Your machine needs to be usable by you (for setup and running), but other people should be able to see when it has started and when it has ended.

1. **Brainstorm, Plan, Design:** Work with your partner to make a plan for your machine. Be sure to draw out a diagram in your engineering notebook of how you think you'll build your machine!
2. **Prototype Machine:** Get building! Head to the Makerspace and start putting together your actual machine. You'll need to stick within the constraints of using only posterboard, string, and hot glue. Don't forget that your machine has to fit on a single yellow foam tray too!
3. **Test & Evaluate:** As you work on your machine, continually test and evaluate its success to fine-tune it! In the end, you need to make 5 complete runs in which at least 3 are within 0.1 seconds of the goal time: 6 seconds. Remember that this time is measured from the *start* of the marble motion until the *end* of marble motion!

Part 3: Tasks	*10-8 points*	*7-5 points*	*4-0 points*
Brainstorm, Plan, Design	+ You worked with your partner to make a plan! + Your plan includes a drawing in your engineering notebook!	- Your diagram is not detailed enough to communicate the ideas	- Your diagram is missing - You did not work with your partner to plan
Prototype Machine	+ You built a machine! + The machine is clearly influenced by your plan + Your machine includes at least 3 different simple machines	- Your machine is not totally complete - your machine only includes 2 simple machines	- Your machine is missing - Your machine only uses 1 simple machine
	20-15 points	*14-10 points*	*9-0 points*
Test & Evaluate Machine	+ Your Rube Goldberg machine works 3 out of 5 times + Your Rube Goldberg machine meets the criteria & constraints outlined in the design brief	- Your machine works 2 out of 5 times - Your machine meets most of the criteria & constraints	- Your machine works 0 or 1 time out of 5 - Your machine does not meet the requirements