Pre-Engineering Program

A LEGO® Education Program

Advanced Simple Machines Program

Pre-Engineering Advanced Program

LEGO® Education Simple Machines Advanced Program

Simple and Powered Machines Program Overview:

This 4-day, advanced pre-engineering program outline will provide students with STEM focused hands on activities to promote 21st century skills as well as design engineering. Each day, students will participate in team building activities, engage in opportunities for physical activity, and receive a daily team briefing for daily challenges aligned to standards. Daily challenges will help students develop skills and knowledge to complete the culminating project of designing a Rube Goldberg machine.

	Essential Questions	Daily Activities
Day 1	**Welcome to Orientation** What are levers? How do they make work easier?	Types of Levers Feel the difference of effort needed Catapult
Day 2	**Using Inclined Planes and Cams** How does an inclined plane help with movement? How does a cam work?	Principles to Models Inclined Planes and Cams Dragster Walker
Day 3	**Combining it All – Complex Machines** How can simple machines be combined to make more complex machines?	Combining Simple Machines Planning and creating a Rube Goldberg machine
Day 4	**Completing the Rube Goldberg Machine** How can simple machines be combined to make more complex machines?	Final Details Rube Goldberg machine presentation

Prior to First Day of the Program:

1. Sort the sets.
2. Add the AA batteries to the battery pack. Make sure they are turned off. You might wish to keep all the battery packs in a secure location so they are not turned on accidentally. They are used on Day 4.
3. Determine a naming convention for each set and label. Suggestions include school initials and a number (Example: Millcreek Elementary simple machine sets names could be MES1; MES2; MES3) and write name on the battery pack and the motor and on the set.
4. Gather any consumable materials needed for the week.
5. Determine a procedure for when a LEGO piece is dropped (everyone freeze; say LEGO® down/LEGO® found) and where to place LEGO® pieces if found and does not belong to the finder.
6. Marbles or other heavy spheres will be needed for the Rube Goldberg machines.

Pre-engineering Program Day 1

Welcome to Orientation

Big Question:

- What are levers?
- How do they make work easier?

Materials needed for the day:

- Simple and Powered Machines sets
- Chart paper
- Student journals (could be paper stapled together with students creating the outside of the journal using construction paper and other consumable materials)
- Various craft materials for use with Rube Goldberg
- Pens
- Pencils
- Markers
- Tape – masking, duct, painters, cellophane

Outline of Day	**Tasks**	**Time**	**Materials**
9:00 - 10:30	Introductions	30 min	• LEGO® bricks
	Establishing Group Rules and Expectations	15 min	• Chart paper • Markers • Pens
	Team Building Activity	15 min	• LEGO® bricks • Objects such as water bottles or packs of sticky notes
	Team Briefing 1	5 min	• None
	Partner Selection, Team Name and Team Badge	25 min	• Team badge templates • Markers • Pencils • Scissors

10:30 - 10:35	Break		
10:35 - 11:25	Workplace Wellness (physical activity)	10 min	• Varies, based on the activity selected
	Design a Journal	20 min	• Student journals (see note in materials section) • Markers • Scissors • Construction paper • Other craft materials
	Reading and Wondering	20 min	• Book about simple machines • Student journals
11:25 - 11:30	Get ready for lunch		
11:30 - 12:00	Lunch		
12:00 - 2:10	Team Briefing 2	5 min	• None
	Challenge 1: Exploring Levers A1, A2, A3	30 min	• Student journals • Simple and Powered Machines sets • Student worksheets • Booklet I
	Team Briefing 3	5 min	• None
	Challenge 2: Catapult	75 min	• Student journals • Simple and Powered Machines sets
	Break	5 min	• None
	Disassemble and Inventory Sets	15 min	• Simple and Powered Machines sets
2:10 - 2:30	Daily debrief and wrap up	20 min	• Student journals

Introductions

Time: 30 minutes
Materials:

- Loose LEGO® bricks

Purpose: For students to get to know each other

Show a video of a Rube Goldberg machine asking students to look at different parts of the machine to see how it works. Using the LEGO® bricks, have students build that shows something they really like to do and one thing they really hope to learn at simple machines program. When time to share, have students say their name and share their model. The teacher can record what the group hopes to learn on a piece of chart paper. Explain they will be making a Rube Goldberg machine and that they can bring materials from home to help make it really cool – like the cardboard cylinders from inside paper towel or toilet paper roles and so forth.

Group Rules and Expectations

Time: 15 minutes
Materials:

- Chart paper
- Markers

Using a piece of chart paper, establish group rules and expectations for the week as a class. You can have students sign the chart paper and then place the rules and expectations in a location that can be reviewed each day.

Team Building Activity

Time: 15 minutes
Materials:

- Loose LEGO® bricks

Explain to students that each day will include some kind of team building challenge. Working together is an important skill and just like other skills, we can practice it to get better and better.

Build a strong tower

Provide each group with a container of loose LEGO® bricks. Have students work together to build the tallest tower they can that will hold the weight of an object. The object could be a water bottle, a dictionary, or a pack of sticky notes. The object needs to be given to each group and needs to be consistent.

At the end of the 5 minutes, encourage students to reflect on:

- What was challenging?
- How did you overcome the challenge?
- What was successful?
- How did you work together?
- If you were to do this tower build again, what would you change?

Team Briefing 1:

Time: 5 minutes
Materials: None

Welcome to orientation! Your first tasks for today are as follows:

- *Determine a partner for training exercises*
- *Work with partner to determine a name for your design company and a logo*
- *Your company will create a ball moving machine by the end of the week*
- *Design a journal for keeping important records this week*
- *Explore different ways we use simple machines*

Partner Selection, Design Company Name, and Logo

Time: 25 minutes
Materials:

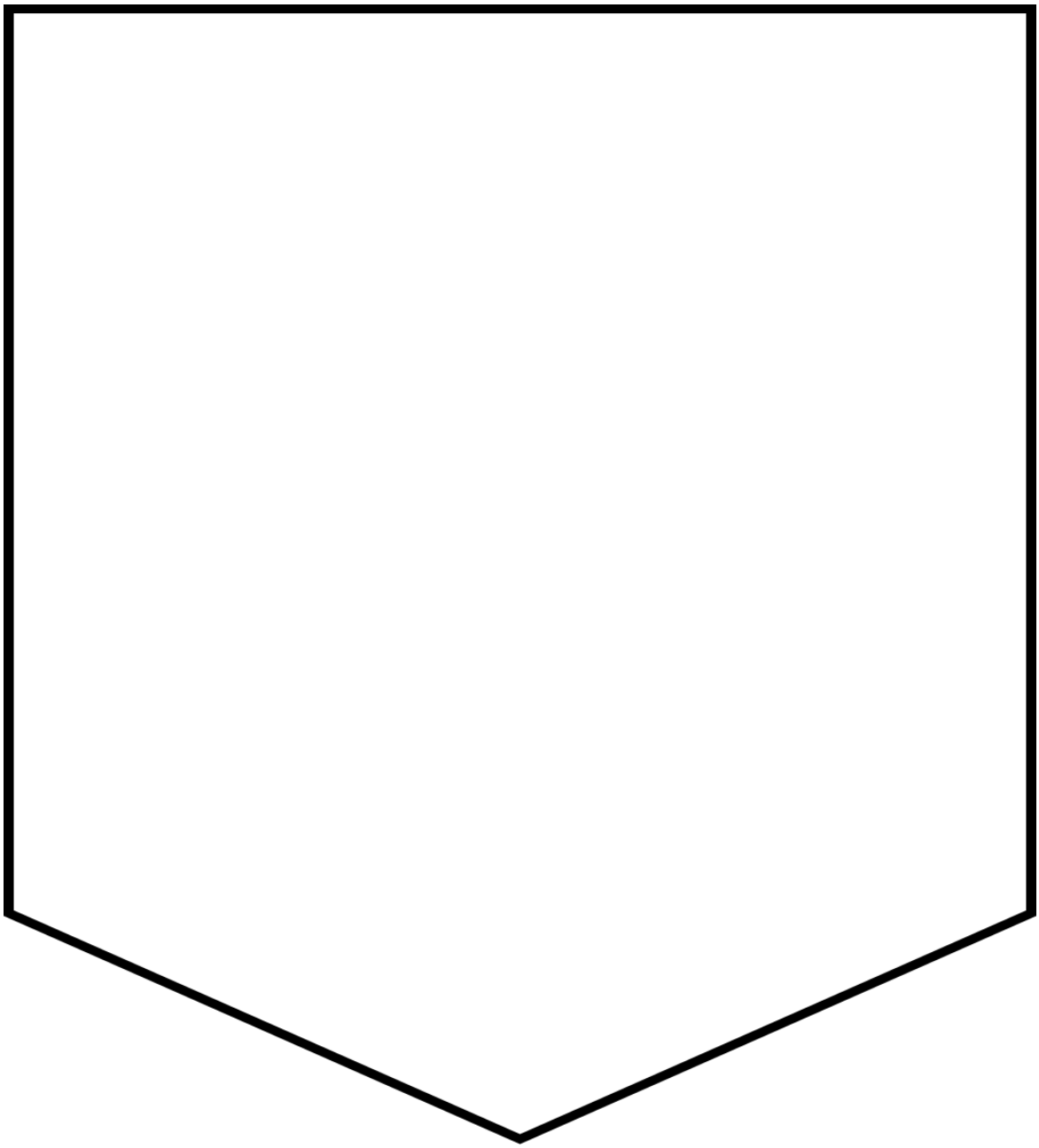
- Markers
- Scissors
- Construction paper
- Other craft materials

You can use several different activities to help students find a partner to work with for the week. An internet search can help you find several ideas.

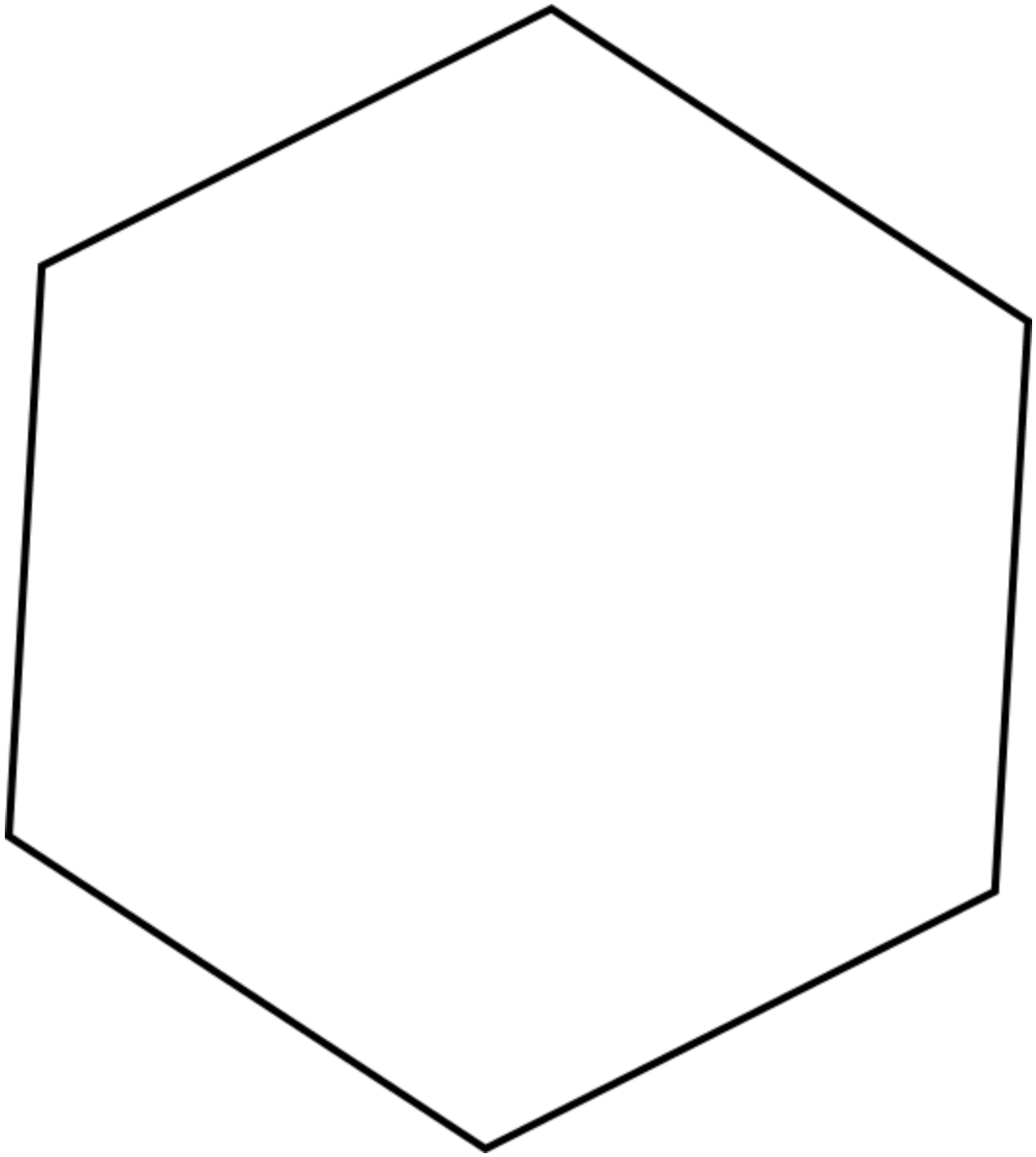
Once partners have been established, student teams can determine a design company name (team name) for their team and design a logo.

While teams are working, assign each group a Simple and Powered Machines set to use for the week.

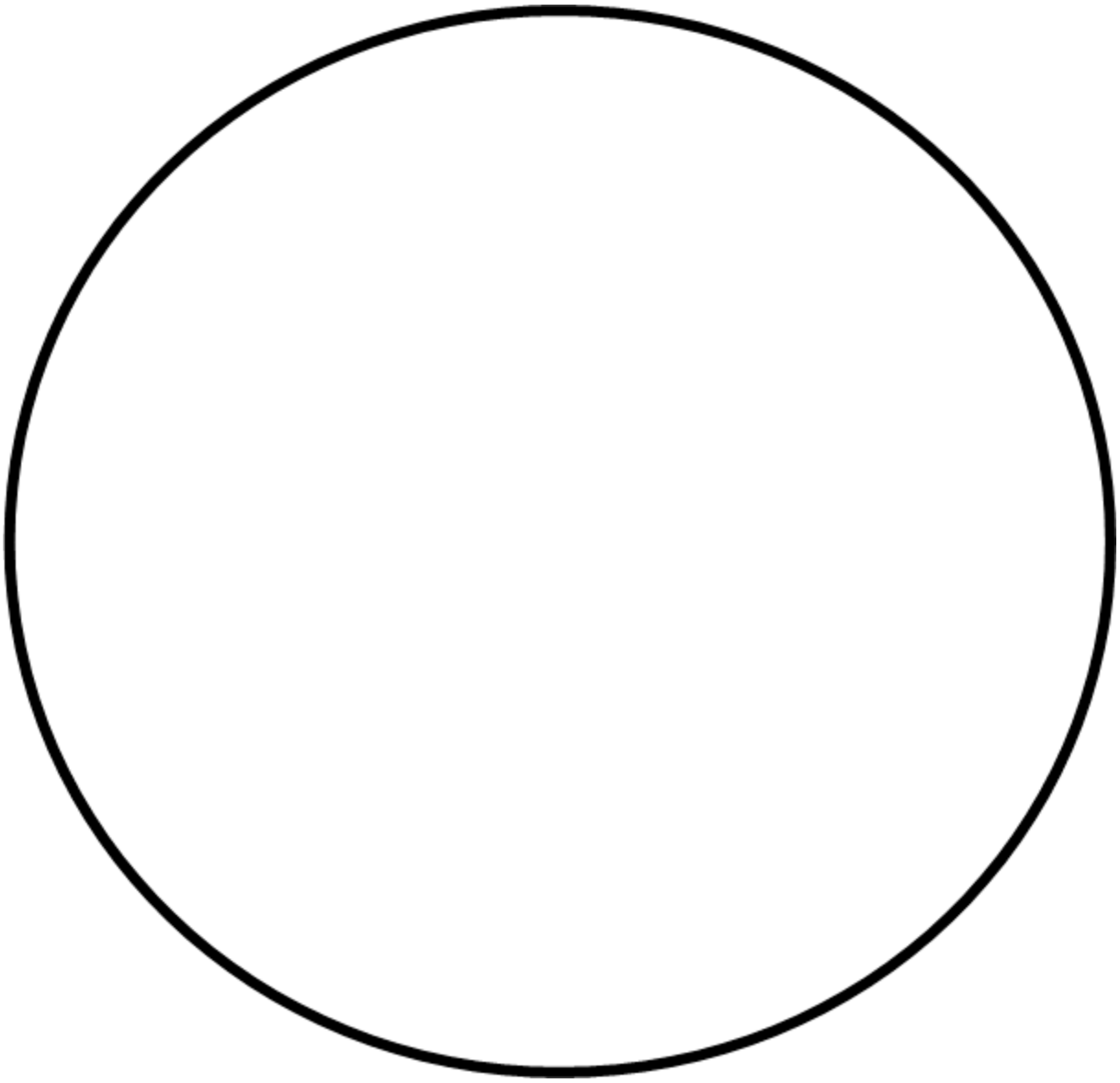
Logo Templates



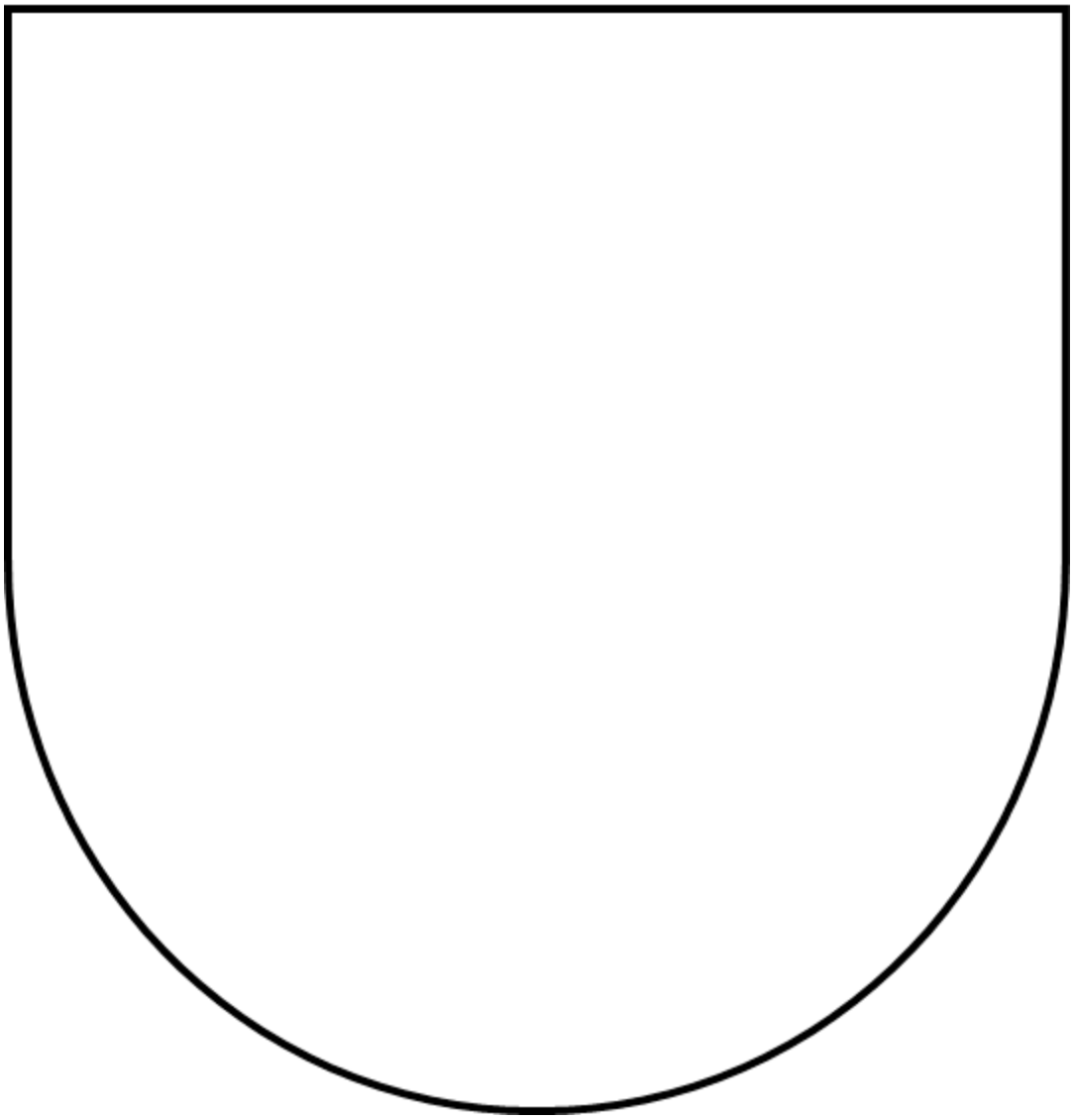
Logo Template



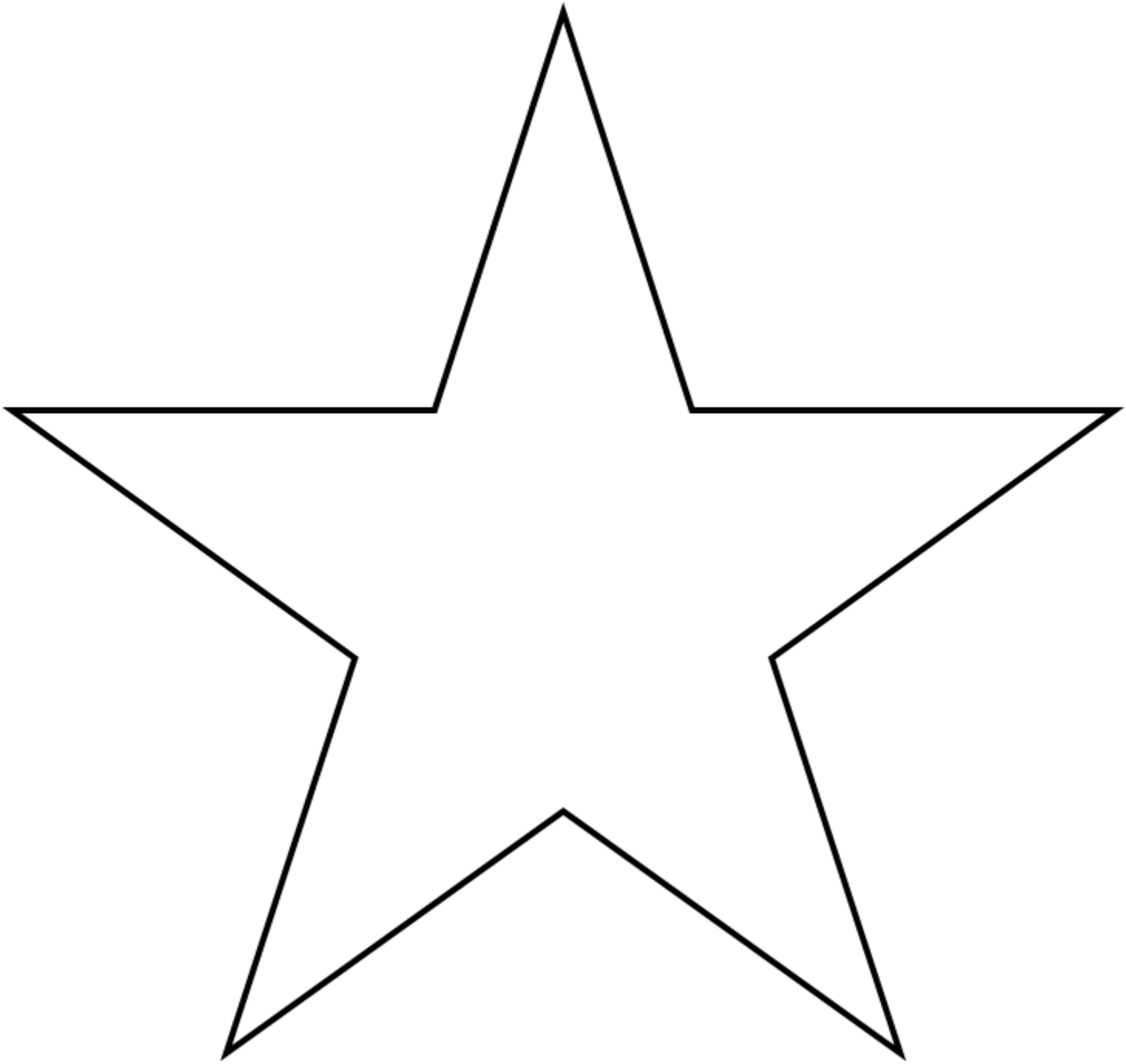
Logo Template



Logo Template



Logo Template



Break

Time: 5 minutes

Workplace Wellness: Physical Fitness

Time: 10 minutes
Materials:

- May vary depending on what activity is selected

Take a minute to complete a short physical activity. There are several websites available with suggestions for physical activities. Activities include ideas like jumping jacks or running in place.

Design a Journal

Time: 20 minutes
Materials:

- Student journals (see note in materials section)
- Markers
- Scissors
- Construction paper
- Other craft materials

Have students create a design journal to take notes, share wonderings, write reflections and collect ideas. Ideas for types of journals can be found online.

Readings and Wonderings

Time: 20 minutes
Materials:

- Book or articles about levers

Read a book or a kid friendly journal article about levers and what they can do to make work easier. Have students write things they wonder about levers in their journals.

Lunch

Time: 30 minutes

Team Briefing 2

Time: 5 minutes
Materials: None

> *Now that you have your team and have some background information about simple machines, you have a new challenge. To be better prepared for the days ahead, you will need some*

basic training on the tools we will use this week. Your mission this afternoon is to explore how machines use levers.

Be sure to work together, take good notes, and have fun.

Go over a few general guidelines for using the Simple and Powered Machines sets (what to do if you drop a piece on the floor, where do you put a piece you have found, what does sharing look like, etc.).

Challenge 1 – Exploring Levers

Time: 30 minutes
Materials:

- Simple and Powered Machines sets
- Student journals
- Building Instruction Booklet I
- Student worksheets for Levers

Students will:

- Create models of the three classes of levers.
- Determine where the effort, fulcrum, and load are located on each type of lever.
- Determine the location of the effort, fulcrum, and load for each type of lever so the effort required is the least.
- Think of ways that levers could be utilized.

Ask students questions like:

- Why do engineers use simple machines, specifically a lever?
- How a lever can make work easier?

Part 1

Have students complete the principle model activity A-1, A-2 and A-3, which can be located at https://education.lego.com/en-us/lessons/spm/lever#Planitem2. This site contains lesson plans, student worksheets, building instructions, and teacher notes. Have students explain how they work and why they would be used. Complete the worksheets during the lesson. Students should take notes in their student journals. They should be able to answer questions like:

- Where are the effort, fulcrum, and load are located on each class of lever?
- Where should the effort, fulcrum, and load be located on each class of lever so the effort required is the least?
- How can levers could be utilized?

Team Briefing 3

Time: 5 minutes
Materials: None

Levers have been used for thousands of years. One of the ways levers have been used is in disputes. Catapults have been used throughout history in both offensive and defensive ways. Can you create a catapult and then become accurate with using it? How does your knowledge about levers help with this?

Challenge 2: Catapult

Time: 70 minutes
Materials:

- Simple and Powered Machines Sets
- Student journals
- Objects to be tossed
- Locations/containers for targets

Have students complete the catapult activity, which can be found at https://education.lego.com/en-us/lessons/advancing-with-spm/catapult. This site has lesson plans and teacher notes. This is an open-ended lesson. Students need to create their own catapult – no building instructions should be provided. If you need to provide building instructions, Booklet I could be used.

Have locations where students can put the catapult and from that location score points by getting a small object – the small tires – into designated areas or containers each worth differing amounts of points. These areas should be a variety of distances from the catapult and not all in a straight line.

Ask students to write in their journals:

- How do you adjust your catapult to move an object a long distance?
- How do you adjust your catapult to move an object a short distance?
- How does the length of the lever in the catapult affect the distance the object moves?

Break

Time: 5 minutes

Disassemble and Inventory Check

Time: 15 minutes
Materials:

- Simple and Powered Machines sets

Ask students to take apart their catapult model. Then, working with their partner, students will work to conduct an inventory check of the pieces in their set to ensure all pieces are in the correct spots and no pieces are missing.

For a full inventory: Have students place item from one compartment on the lid of the box. Then, using the paper insert in the set (the one that is placed under the lid of the box) have students count and replace pieces back to the compartment. Teams should be able to complete two compartments in ten minutes. If pieces are missing, have students search other compartments, looks to see if the piece is stuck in or on another piece of check the LEGO® lost and found area in your classroom.

For today, we suggest you conduct only a “quick inventory” of the sections that pieces from the gearing model came from. Students will not need to count pieces from all sections and it will be a quicker check of their materials.

Daily Debrief and Wrap Up

Time: 20 minutes
Materials:

- Sticky notes
- Student journals
- Pencils
- Pens
- Markers

Have students use sticky notes to write down three things they really enjoyed about the day. Have students use a different sticky notes to write down one thing they are still wondering about. Place sticky notes in student journals.

Pre-engineering Program Day 2

Using Inclined Planes and Cams

Big Questions:

How does an inclined plane help with movement?
How does a cam work?

Materials needed for the day:

- Simple and Powered Machine sets
- Chart paper
- Student journals
- Various craft materials
- Pens
- Pencils
- Markers

Outline of Day	Tasks	Time	Materials
9:00 - 9:50	Welcome	5 min	• Student journals
	Team Building Activity	15 min	• LEGO® bricks
	Review Group Rules Chart	5 min	• Group Rules Chart
	Team Briefing 1	5 min	• None
	Readings and Wonderings .	20 min	• Book or journal article about gears used in machines
9:50 - 10:50	Challenge 1: Inclined Planes	60 min	• Simple and Powered Machines sets • Student journals
10:50 - 10:55	Break		
10:55 – 12:05	Workplace Wellness (physical activity)	15 min	• Varies, based on the activity selected

	Team Briefing 2	5 min	• None
	Challenge 2: The Walker	50 min	• Simple and Powered Machines sets • Student journals
12:05 - 12:10	Get ready for lunch		
12:10 - 12:45	Lunch		
12:45 - 12:50	Team Briefing 3	5 min	• None
12:50 - 2:10	Challenge 3: Dogbot	75 min	• Simple and Powered Machines Sets • Student journals
	Break	5 min	• None
2:10 - 2:30	Clean Up, Daily Debrief, and Wrap Up	20 min	• Student journals

Welcome

Time: 5 minutes
Materials:

- Student journals

Welcome students back! Have students take a minute to read over the sticky notes placed in their journals from the previous day. Have students share their favorite moments from the previous day with a partner.

Team Building Activity

Time: 15 minutes
Materials:

- LEGO® bricks

You will need identical sets of bricks. For example, if you have 5 groups, you will need 6 sets of identical bricks- one for the model you build and one set for each team.

Relay race

- Introduce the Relay race activity as described below.
- Give the participants approximately 10 minutes to complete the activity.
- Create teams of 4-5 participants.
- Build and hide model of 12-15 LEGO® bricks, you decide how it looks – remember, it should not be too easy to copy!

Remember to say/cover the following points:

- Work in teams of 4-5.
- The facilitator builds a model of 12-15 bricks and hides it at the far end of the room, behind an obstacle.
- Teams line up and one from each team runs to see the model.
- When the team member returns to base, he/she can place one brick, then the next team member runs, etc.
- The aim is to copy the hidden model as fast as possible.

Tips

- Variations - the teams cannot talk while working on building the model

Review Group Rules Chart

Time: 5 minutes
Materials:

- Group Rules Chart (from Day 1)

Quickly review the group rules and expectations created on Day 1 by the students. Highlight positive moments from Day 1 (times when students helped each other, asking great questions, teamwork, helping to clean up…)

Team Briefing 1

> *Hello, fellow engineers! Yesterday, you worked with levers and built a catapult. Today, you will learn about and how to use cams and inclined planes. These simple machines may help you later this week when you build your own ball moving machine.*

Readings and Wonderings

Time: 20 minutes
Materials:

- Videos on machines that use inclined planes and cams and mechanical advantage
- Internet research
- Student journals

Students should research inclined planes and cams. Where are they used? Why? What is mechanical advantage? Read and discuss inclined planes and cams and how they move or cause movement.

Have students write the types of machines that use inclined planes and cams. Watch some short videos on mechanical advantage.

Challenge 1: Inclined Planes and Cams

Time: 45 minutes
Materials:

- Simple and Powered Machine sets
- Student journals
- Building Instruction Booklet I
- Building Instruction Booklet II
- Ruler

Complete the inclined plane principle model D-1, which can be found at https://education.lego.com/en-us/lessons/advancing-with-spm/inclined-plane#Planitem0
This site contains building instructions, teacher notes, and student worksheets for inclined planes. This model shows a short inclined plane. Test different amounts of weight. Complete the student worksheet during the lesson.

Measure the length and height of the inclined plane. What is the mechanical advantage? Have students write important ideas in their journals.

Complete the inclined plane principle model D-2, which can be found at https://education.lego.com/en-us/lessons/advancing-with-spm/inclined-plane#Planitem0
This site contains building instructions, teacher notes, and student worksheets for inclined planes. This model shows a long inclined plane. Test different amounts of weight. Complete the student worksheet.

Measure the length and height of the inclined plane. What is the mechanical advantage? Have students write important ideas in their journals.

Complete the inclined plane principle model H-1, which can be found at https://education.lego.com/en-us/lessons/advancing-with-spm/cam. This site contains building instructions, teacher notes, and student worksheets for cams. This model shows a double cam mechanism. Complete the student worksheet during the lesson.

What part of the mechanism is the follower? Have students write important ideas in their journals.

Break

Time: 5 minutes

Workplace Wellness: Physical Fitness

Time: 15 minutes
Materials:

- May vary depending on what activity is selected

Take a minute to complete a short physical activity. Ideas can be found on many internet sites. Simple exercises like jumping jacks or running in place can be used. Consider having students move like a walking robot to prepare them for the next challenge.

Team Briefing 2:

> *Hello Engineers! You have learned about inclined planes and cams so far today. You learned about levers previously. Now, you are ready to apply your knowledge to a real machine. Let's build a machine that walks.*

Challenge 2: The Walker

Time: 70 minutes
Materials:

- Simple and Powered Machine sets
- Student journals
- Building Instruction Booklets 13A and 13B
- Student worksheets

Can you make a machine that walks? Complete the Walker model, which can be found at https://education.lego.com/en-us/lessons/spm/the-walker#Planitem1. This site contains teacher notes, student worksheets and building instructions. Have students complete the student worksheet.

When the model is complete, each of the partners should make the model move forward and backward. Students should explain where they see a lever, gear, and ratchet used. Add this information to the student journals.

Students should take apart their models and put the pieces accurately back into the correct tray locations.

Have students write a brief reflection on the activity in their design journals.

- What was easy about this challenge?
- What was difficult about this challenge?
- What did I learn from this challenge?

Note: If you see that students need more time to complete The Walker, please continue the activity after lunch.

Lunch

Time: 30 minutes

Team Briefing 3

Time: 5 minutes
Materials: None

Now that you have investigated cams, it is time to have some fun with them. You can make a machine that imitates a dog. How will the cams affect the way that the dog behaves?

Challenge 3: Dogbot

Time: 80 minutes (Take a 5 minute break in the middle of the lesson.)
Materials:

- Simple and Powered Machines sets
- Student journals
- Building Instruction Booklets 14A and 14B
- Student worksheets - Dogbot

Can you create a mechanical Dog? Complete the Dogbot model, which can be found at https://education.lego.com/en-us/lessons/spm/dogbot. This site contains building instructions, teacher notes and student worksheets. Have the students complete the student worksheet.

Have students write a brief reflection on the activity in their design journals considering the following questions.

- How do the position of the cams affect Dogbot's eyes?
- How do the position of the peg position affect Dogbot's jaw?
- How do the position of the pulley setting affect Dogbot's tail?
- What did I learn from this challenge?

Cleanup, Daily Debrief, and Wrap Up

Time: 20 minutes
Materials:

- Student journals
- Markers
- Colored pencils
- Crayons

Have students take apart the models and put the pieces back into the correct locations in the bin trays.

Have students write one word that they feel reflects what they have learned today. Write and illustrate the word in their student journals.

Pre-engineering Program Day 3

Combining it All – Complex Machines

Big Question:

How can you combine simple machines to make complex machines?
How does a Rube Goldberg machine work?

Materials needed for the day:

- Simple and Powered Machine sets
- Student journals
- Various craft materials
- Balls (marbles or heavy round spheres seem to work best)
- Pens
- Pencils
- Markers
- Optional: ramps, tubes from paper products, tape (various), straws, string

Outline to Day	Tasks	Time	Materials
9:00 - 10:30	Welcome	5 min	• Student journals
	Team building activity	15 min	• LEGO® bricks
	Review Group Rules Chart	5 min	• Group Rules Chart
	Team Briefing 1	5 min	• None
	Readings and Wonderings	10 min	• Internet research • Student journals
	Inventory Check	5 min	• Simple and Powered Machines sets
	Challenge 1: Table to Floor	45 min	• Simple and Powered Machines sets • Student journals • Balls • Containers

			• Various craft materials
10:35 - 10:40	Break		
10:45 - 10:45	Team Briefing 2	5 min	• None
10:45 - 11:25	Challenge 2: Moving a Ball Up	40 min	• Simple and Powered Machines sets • Student journals • Balls • Containers • Various craft materials
11:25 - 11:30	Get ready for lunch		
11:30 - 12:00	Lunch		
12:00 - 1:45	Workplace Wellness (physical activity)	10 min	• Varies, based on the activity selected
	Team Briefing 3	5 min	• None
	Challenge 3: Side to Side	60 min	• Simple and Powered Machines sets • Student journals • Balls • Containers • Various craft materials
1:45 - 1:50	Break	5 min	

1:50 – 2:40	Challenge 4: Putting it Together	50 min	• Simple and Powered Machines set • Student journals • Balls • Containers • Various craft materials
2:40 – 3:00	Clean Up, Daily Debrief and Wrap Up	20 min	• Student journals

Welcome

Time: 5 minutes
Materials:

- Student journals

Welcome students back! Have students take a minute to share their word they create the day before with a neighbor. Compile a list of the words as a group. You can create a word cloud to share on the last day of the program.

Team Building Activity

Time: 15 minutes
Materials:

- Sets of identical LEGO® bricks (Each pair of students will need the same set of 6 bricks; sets may vary among groups.)

Pair students together. Designate one student as Designer and one student as Builder.

Back to Back

Students will sit back to back. The designer will build something using the bricks they have without letting their partner see. When the build is complete, the Designer will communicate to the Builder the steps to create the exact same build without looking at them. The Builder may not ask questions. The

Builder may say “Repeat, please” if needed. The goal is for the students to have the same build. After the team completes, they should compare models to see if they match exactly.

Have students change roles and try again.

Review Group Rules Chart

Time: 5 minutes
Materials:

- Group Rules Chart (from Day 1)

Quickly review the group rules and expectations created on Day 1 by the students. Highlight positive moments from Day 2 (times when students helped each other, asking great questions, teamwork, helping to clean up…)

Team Briefing 1

Time: 5 minutes
Materials: None

> *Hello! This morning, your task is to investigate different ways we combine to make a ball moving machine. Have you seen machines that constantly move balls from one place to another – up and down, side to side? You will be building a little part of the machine at a time and then tomorrow, will have completed one larger complex machine.*

Research and Wonderings

Time: 10 minutes
Materials:

- Student journals

Discussion and Internet search on Rube Goldberg machines and how many different types of simple machines are used to move balls. Have students take notes on ideas they might like to try in their student journals.

Inventory Check

Time: 5 minutes
Materials:

- Simple and Powered Machines sets
- Student journals

Ask students to find their partner from Day 1. Have students check to see all items in the bin and are in the proper trays.

Challenge 1: Table to Floor

Time: 45 minutes
Materials:

- Simple and Powered Machine sets
- Student journals
- Balls
- Container
- Various craft materials

Build a machine to move balls from a specific location on a table to a specific location on the floor. You are striving for 80% or better accuracy, meaning the balls should land and stay in the location at least 80% of the time.

> **Note:** If you have students who prefer to use bricks instead of balls, that is fine. However, the bricks may be harder to move because they do not roll. Other tasks may be easier for balls instead of bricks.

Have students reflect in their journals:

- What was easy about this challenge?
- What was difficult about this challenge?
- What did I learn from this challenge?

Break

Time: 5 minutes

Challenge 2: Going Up

Time: 40 minutes
Materials:

- Simple and Powered Machines set
- Student journals
- Balls
- Container
- Various craft materials

Build a machine that can lift a ball up and place it into a container at least 3 inches above the starting surface. You are striving for 80% accuracy in placing balls in a specific location.

Lunch

Time: 30 minutes

Workplace Wellness: Physical Fitness

Time: 10 minutes
Materials:

- May vary depending on what activity is selected

Take a minute to complete a short physical activity. Ideas include standing on one foot and hopping, balancing an object on your head and bumping elbows with 5 different people. Other ideas can be found on the internet.

Team Briefing 3

Time: 5 minutes
Materials: None

> *Today, you will make a ball move side to side into a specified location and stay there – meaning not roll or fall out. You should take the knowledge you have from the previous two activities and use them for this challenge.*

Challenge 3: Side to Side

Time: 60 minutes
Materials:

- Simple and Powered Machines set
- Student journals
- Balls
- Container
- Various craft materials

Build a machine that can move a ball from specific locations left to right or right to left. Set up an area with a containment that your ball must enter and stay in. You are striving for at least 80% accuracy.

Have students reflect in their journals:

- What was easy about this challenge?
- What was difficult about this challenge?
- What did I learn from this challenge?

Team Briefing 4

Time: 5 minutes
Materials: None

> *Tomorrow you will be creating a full Rube Goldberg machine. You will be able to bring in any other materials you want to use tomorrow to help make a really cool machine. You will also be*

able to work with other groups. You may want to do a bit of research on other Rube Goldberg machines to give you some novel ideas.

The challenge tomorrow will be to move a ball the farthest with your Rube Goldberg machine. Remember the machine does not have to contain only pieces from the Simple and Powered Machines sets. You can use any materials you want to bring from home (or that the teacher has brought).

Today you should start your planning. If you want to work with another or several groups, make sure everyone agrees you are going to work together today and plan together. You will need to move the ball up and down, side to side, and, of course, forward. Use gravity to help!

Hint: You can use your battery pack and motor in any position you want – even moving it as need be – if you desire.

Challenge 4: Putting it Together

Time: 50 minutes
Materials:

- Simple and Powered Machines set
- Student Journals
- Balls
- Container
- Various craft materials

Tomorrow, you will be creating a full Rube Goldberg machine. The challenge tomorrow will be to move a ball the farthest with your Rube Goldberg machine. You can use any materials you want to bring from home or that the teacher has brought.

You should work together in the groups you choose and everyone should have a plan designed in their student journals. By the end of the day, each person should have a list of what they will bring tomorrow, if anything. Each person should know what they are working on for the part of the machine they are making. You will have about 200 minutes to work on your projects tomorrow.

Daily Debrief and Wrap Up

Time: 20 minutes
Materials:

- LEGO® Bricks
- Student journals

Have students use LEGO® bricks to build a model that represents two things they learned today. Reiterate to the students that tomorrow they can bring in anything that they would like to use to help with the Rube Goldberg machine.

Pre-engineering Program Day 4

Rube Goldberg Machine

Big Question:
How can simple machines be combined to make a Rube Goldberg machine that can move a ball the farthest?

Materials needed for the day:

- Simple and Powered Machines
- Student journals or journals
- Various types and sizes of paper
- Various craft materials
- Tubes from paper products
- Balls
- Old magazines that can be cut up (optional)
- Pens
- Pencils
- Markers
- Tape (several types)
- Any found objects students want to bring in
- Ramps (optional)
- Cardboard (optional)
- Foam (optional)

Outline for Day	**Tasks**	**Time**	**Materials**
9:00 - 10:35	Welcome	5 min	• Student journals
	Team Building Activity	15 min	• LEGO® bricks
	Review Group Rules Chart	5 min	• Group Rules Chart
	Team Briefing 1	5 min	• None

	Research and Wonderings	10 min	• Discussion • Internet research • Student journals
	Inventory Check	5 min	• Simple and Powered Machines sets
	Challenge 1: Consistent Movement	50 min	• Simple and Powered Machines Set • Student journals • Balls • Various materials • Containers
10:35 - 10:40	Break		
10:40 - 10:45	Team Briefing 2	5 min	None
10:45 - 11:50	Challenge 2: Going Up and Down	65 min	• Simple and Powered Machines sets • Student journals • Balls • Various materials • Containers
11:50 - 12:00	Get ready for lunch		
12:00 - 12:30	Lunch		
12:30 - 2:00	Workplace Wellness (physical activity)	10 min	• Varies, based on the activity selected
	Team Brief 3	5 min	• None
	Challenge 3 Culminating Activity: Rube Goldberg Machine	450 min	• Simple and Powered Machines sets • Student journals • Balls • Various materials

			• Containers
	Show Case: Rube Goldberg Machine	30 min	• Simple and Powered Machines sets • Student journals • Balls • Various materials • Containers
2:00 - 2:30	Clean Up Daily Debrief and Wrap Up Celebration	30 min	• Simple and Powered Machines sets • Student journals • Certificates

Welcome

Time: 5 minutes
Materials:

- Student journals

Welcome students back!. Have each student share their models from Day 3 debrief with a friend as a way to review what they had learned yesterday.

Team Building Activity

Time: 15 minutes
Materials:

- LEGO® bricks

Build Something That

- Work in groups of 4-5.
- Place the bricks in front of you.
- The teacher will name a category and your group will build 2-3 items that belongs in this category.
- When done building, please explain why this item belongs in the category.

Build something that:

- *can fly*
- *is an animal*
- *can be used for transportation*
- *you can have for lunch or dinner*

Tip: Ideas for other categories include a movie, cartoon characters, buildings, and so forth.

Review Group Rules Chart

Time: 5 minutes
Materials:

- Group Rules Chart (from Day 1)

Quickly review the group rules and expectations created on Day 1 by the students. Highlight positive moments from Day 3 (times when students helped each other, asking great questions, teamwork, helping to clean up…)

Team Briefing 1

Time: 5 min
Materials: None

> *Today, you will create your Rube Goldberg machine to move a ball the farthest. I hope you and your teammates for this project remembered to bring the items you wanted. If not, improvise! You will be working together today to create a really fun machine to move a ball. To start, make your ball go at least 2 feet. You choose the starting position and the place you want the ball to end up for the next action in your design. Measure out at least two feet and then work to get the ball moving at least two feet.*

Research and Wonderings

Time: 10 minutes
Materials:

- Discussion and Internet research
- Student journals

Have students get a few more ideas during this time – perhaps researching how to use some of the materials they brought or looking at videos of some cool Rube Goldberg machines.

Inventory Check

Time: 5 minutes
Materials:

- Simple and Powered Machine sets
- Student journals

Ask students to find their partner from Day 1. Have students confirm that all pieces in the bin are in the correct tray compartments.

Challenge 1: Consistent Movement

Time: 50 minutes

Materials:

- Simple and Powered Machine sets
- Student journals
- Balls
- Various materials
- Containers
- Ramps (optional)

Students should work with their teams set up yesterday. Begin to make your Rube Goldberg machine. See if you can accurately get your ball to move at least 2 feet. You are striving for 80% or better accuracy for moving your ball from Point A to Point B. You determine the locations, but make sure it measures at least 2 feet. When you have that completed, continue your creation.

Break

Time: 5 minutes

Team Briefing 2

Time: 5 min
Materials: None

> *Continue building your design. Make sure you have something that will make your ball go up and another section that allows your ball to roll down. Persevere with your designs, modifying as needed. Work together. Be compassionate and helpful. Remember this is probably everyone's first time to make a machine together. Learn from each other. Ask for help or ideas if things don't go the way you want.*

Challenge 2: Going Up and Down

Time: 65 minutes
Materials:

- Simple and Powered Machine sets
- Student journals
- Balls
- Various materials
- Containers
- Ramps (optional)

Continue to add to your machine. Make sure it has sections where the ball moves up and other sections where it moves down.

Lunch

Time: 30 minutes

Workplace Wellness: Physical Fitness

Time: 10 minutes
Materials:

- May vary depending on what activity is selected

Take a minute to complete a short physical activity. Ideas can be found on several internet sites. You may wish for students to pretend to be a machine. Have students stand in a circle with arms out from their sides. Have them act in a wave where a hand touch causes the person to move their arm in an arc and touch the next persons hand. You can chose a start or start it yourself and continue to start at different intervals.

Team Briefing 3

Time: 5 min
Materials: None

> *Complete your building your design. Then, determine how you will present your designs for the guests that will arrive this afternoon. You should be able to identify the simple machines used in your complex machine – levers, inclined planes, gears, etc. You may want to work together to identify and then write in your journals. You can use your journals as a reference during the presentations.*

Culminating Project: Rube Goldberg Machine

Time: 45 minutes
Materials:

- Simple and Powered Machines sets
- Student journals
- Balls
- Various materials
- Containers
- Ramps (optional)

Complete the machine. Students will have 30 minutes for presenting the finished machines to parents and visitors. As students are working, ask them to explain the simple machines used in each section of the machine. They should be able to explain during the presentation.

Showcase: Rube Goldberg Machine

Time: 30 minutes

Materials:

- Simple and Powered Machines sets
- Student journals
- Balls
- Various materials
- Containers
- Ramps (optional)

Have students show their machines and explain how each section works and the simple machines used.

Cleanup, Daily Debrief, Wrap Up and Celebrate

Time: 30 minutes
Materials:

- Simple and Powered Machines sets
- Student journals
- Certificates

Celebrate success. Give students Certificates of Completion. Allow students to take apart their machines. Sort the Simple and Powered Machines sets and do a complete inventory.

Have students write in their journals about their machines.