**Saturday Science Teaching – Fall 2018**

**Lesson Plan**

 **LESSON #1 - Building Bridges**

**1-2 Grade**

A) LEARNING OBJECTIVES

* Students will be able to engineer their own functioning bridge that can support weight crossing it.
* Students will be able to defend their reasoning and support their idea with evidence.
* Students will be able to demonstrate creating a plan and executing it, collaborate, engineering, problem-solving, and defend reasoning.

B) TEACHER CONTENT KNOWLEDGE

* Teachers must have a solid foundation on the engineering process. The engineering design process is a series of steps to follow when one is designing something or trying to solve a problem. The engineering process consists of five steps: ask, imagine, plan, create, and improve. You begin by asking a question of something you want solve. You then brainstorm different ideas and plan what you want to do. After planning, you begin to create your idea using a variety of materials. After creating, it is always important to evaluate what you created to see what can be improved.
* Teachers must have a strong grasp on basic physics concepts including force, acceleration, motion, and weight. Force is a push or a pull on an object, acceleration is increasing the rate or speed of something. Motion is the change of a position of an objection over time, while weight is the amount of force acting on an object. Teachers must understand the basic principles of the physics of building a structure. They must know that the structure being built must be able to support the weight of the materials that the bridge is made out of and the materials that go inside/on the structure. The concept of gravity is also important when building structures as gravity works against structures by pulling them down. The concept of force and acceleration comes in where teachers must know that when an object is pushed harder it will travel farther.

C) MATERIALS

* 2 bags of pre cut wooden connectors from MILL
* 1,000 Popsicle sticks
* 30 Straws
* 10 ping pong balls
* 10 small hot wheels cars
* 10 golf balls
* 6 small foil trays
* Hot glue guns and glue
* Elmer’s glue
* Playdough
* 1 piece of anchor chart paper/markers
* Construction paper
* scotch/ masking tape

D) REFERENCES (list ALL references that you borrowed ideas from to develop this lesson – including any handouts you may distribute)

Rosie Revere Engineer by Andrea Beaty

Illustrated by David Roberts

Bridge Powerpoint: <https://docs.google.com/presentation/d/1n4aVg1rFzCm3-7bD87Io3NDMF6TxOnCTm1PxGTzeZFA/edit#slide=id.g42d1af9143_0_1>

E) TENTATIVE TIMELINE (Keep brief—tables work well for this!)

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| 30+ minutes  | Introductions, expectations and read aloud |
| 5 minutes  | Engage: Discussing sturdy objects |
| 10 minutes | Talking about what makes a good bridge |
| 10 minutes | Brainstorm different bridges within groups |
| 45 minutes  | Explore: Create bridges within groups of 4 (6 groups of 4) and testing bridges |
| 15 minutes | Reworking parts of bridge |
| 15 minutes  | Elaborate: Final discussion  |

\*Snack time will be included\*

F) DESCRIPTION OF YOUR LESSON:

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| --- | --- |
| **Engage** | Because this is our first lesson together, we want to spend a good amount of time with introductions and going over procedures. This will be done through our formal introductions and an ice breaker activity for the students to get to know one another. The icebreaker activity will be the students in a circle, and we will ask each student to share their name and their favorite color. The procedures include being respectful to yourself, each other and the equipment, along with restroom procedures, raising our hand to ask/answer a question, and also making sure they are being safe and have self control with materials (i.e. no throwing materials when excited.) Then once they know our procedures, and everyone has introduced themselves, we will transition into our “engage” activity which will be a read aloud. We will begin by posing the question, “What does it mean to be an engineer?”. Then we will read the book *Rosie Revere, Engineer* by Andrea Beaty. Once the book has been read, we can ask engaging questions that get them in the mindset of being little engineers. We can ask again what it means to be an engineer, and also if it’s possible for them to become an engineer, what ideas or inventions they’ve ever thought about that could be something really cool, etc. **Focus Question:** what makes a good bridge? |
| **Explore** | We can then introduce the activity of them building bridges. We will split them into groups and show them all the materials they will be working with. We will hold a class discussion about what materials are considered “sturdy” and which are “flimsy”. We will ask probing questions to get them thinking about what makes a sturdy bridge. Show them various pictures to get them thinking about supporting weight of: 1. Materials the bridge is made of and 2. The objects that will travel across it. Also get them thinking about gravity working against/for the bridge depending on the design of the structure.Then we will show them the variety of foil trays (different size rectangles, circular, etc.) they can use for the base of their bridges. Tell them the tray will be filled with water once their bridge is built and finalized. In their groups, they will brainstorm different bridge models using paper and markers. They will be encouraged to observe the materials available to them by handling them up close. Then they will choose one of their models (or a combination of their models) to start creating their bridge.Once their bridge is built, we will walk around and fill their foil trays with water. They will then be asked to use a straw to blow a ping pong ball, golf ball, and toy car across their bridge without it collapsing. This is them testing the sturdiness of their bridge. Encourage them to focus on weak/strong points of their bridge and record that on a data sheet.Send them back to the drawing board and ask them to either reinforce or build an entire new bridge with new knowledge in mind. We will challenge them to use evidence from their first trial to support the changes they made to their revised/new bridge. They will then re-test their new bridge with the ping pong ball, golf ball, and toy car. Have them record whether or not their new bridge performed better than their last in terms of sturdiness and success in transporting and supporting objects across it. |
| **Explain** | Each group will be asked to describe the part of their bridge that worked the best, and was the most sturdy. Each group will also be asked to share one thing that did not work in their bridge, and each group will discuss why this did not work, based on the things we talked about at the beginning about sturdy, and successful bridges. * What shapes did you use?
* What shapes worked best?
* What considerations did you think about when designing your bridge?
* What would you change if it was larger?
 |
| **Elaborate** | Have a discussion about what it means to be an engineer.* Who can be an engineer?
* What is the purpose of a bridge?
* What are aspects of building a bridge?
* What have we learned about engineering?

We are hoping that this stage gets them excited for the weeks to come, and it is a great way to end the conversation for the day.  |

G) How will you determine if your students achieve the objectives for this week?

We will determine the students achievements by the discussions that we are having throughout the day. Specifically, at the beginning, when we ask them about what are sturdy objects, and what things will make good bridges, we will get a good idea of where they are starting, but through our elaboration questions at the end, we will see if their ideas changed, or how they discussed bridges being useful, and what is means to be an engineer.

H) PEDAGOGICAL FOCUS:

Our focus for this lesson is productive discussion. We made sure to include some sort of productive discussion within each section of the lesson. In the engage section, we incorporated productive discussion by discussing what makes an engineer. During this section, we focus strongly on student input as to what they think an engineer is. In the explore section, we incorporated productive discussion by getting the student’s inputs on what they think makes a “sturdy material.” This discussion will begin in small groups and then come together as a whole. During the explain section we will have a productive discussion about what went well when making the bridges and what did not go well. Lastly, in the elaborate section we will have our final productive discussion about our overarching question for the day. We will also talk about what makes an engineer and what we learned about engineering.

**LESSON #2 - Boats**

A) LEARNING OBJECTIVES

* Students will be able to engineer their own functioning boat that can float and withstand wind.
	+ The assessment for this objective will be the actual boat that the students create.
* Students will be able to defend their reasoning and support their idea with evidence.
	+ The students will be talking in the group about the best parts of their boats and why these were the best parts of their boats. They will be defending their answers in the aspect of explaining the successful and unsuccessful parts of their sail boats.
* Students will be able to demonstrate creating a plan and executing it, collaborate, engineering, problem-solving, and defend reasoning.
	+ Evidence of this will be shown through an exit slip answering the focus question: “What makes a good sailboat?” They will also be brainstorming designs of boats, compromising with their partner, testing it, revising it, retesting it, and giving evidence as to why their changes and decisions were successful.

B) TEACHER CONTENT KNOWLEDGE

* Teachers must have a solid foundation on the engineering process. The engineering design process is a series of steps to follow when one is designing something or trying to solve a problem. The engineering process consists of five steps: ask, imagine, plan, create, and improve. You begin by asking a question of something you want solve. You then brainstorm different ideas and plan what you want to do. After planning, you begin to create your idea using a variety of materials. After creating, it is always important to evaluate what you created to see what can be improved.
* Teachers must have a strong grasp on basic physics concepts including force, acceleration, motion, wind, and weight. Teachers must understand the basic principles of the physics of boats and sails. They must know that the structure being built must be able to support the weight of the materials of the boat to ensure they float on top of water. The sail should also be strong enough to carry the boat through the water without destroying the boat. The concept of force and acceleration comes in where teachers must know that when an object is pushed harder (box fan) it will travel farther.

C) MATERIALS

* 1 or 2 Water Holders (erosion tables)
* 15 Straws
* 30 cardstock paper
* 50 rubber bands
* 30 pencils or markers for recording data
* 10 pieces of cardboard
* 20 pieces of Styrofoam
* 20 scissors
* 100 popsicle sticks
* 100 bamboo skewers
* 7 sponges
* 6 rolls Tape, duct and masking
* 50 marbles or 100 pennies
* 30 pieces of construction paper
* 2 Boxes of Foil
* 1 box wax paper
* 1 Box fan to sail boats
* 3 rolls of string
* Fan (already in room)
* 10 dixie cups
* 1 paper clip

D) REFERENCES (list ALL references that you borrowed ideas from to develop this lesson – including any handouts you may distribute)

E) TENTATIVE TIMELINE (Keep brief—tables work well for this!)

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| --- | --- |
| 15 minutes  | Introductions, Ice Breaker |
| 5 minutes | Engage: Discussing purpose of sails buoyancy of objects |
| 10 minutes | Talking about what makes a good sailboat |
| 10 minutes | Brainstorm different boat designs within groups |
| 45 minutes(with 15 minutes for snack at 10:30am) | Explore: Create boat within partner groups (12 groups of 2) and test to see how fast they can travel |
| 15 minutes | Reworking parts of sailboat |
| 15 minutes | Elaborate: Sink the boat, final discussion, clean up |

\*Bathroom breaks will be included\*

F) DESCRIPTION OF YOUR LESSON:

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| --- | --- |
| **Engage** | Our ice breaker we will be using is “move if…” The students will be standing in a circle and we will have someone in the middle who shares something they like in the scenario of “Move if your favorite color is red” and the students will all move to another spot if red is their favorite color. We will do some examples before for the students, and remind them how to do this safely. The students will be ENGAGED because the start of the activity will be asking them “How many of you have been on a boat before?” and then we will talk about the types of boats they have been on. We will talk about things we notice about boats including similarities and differences. Students will engage in a small activity where they are to draw on a sheet of paper what they believe is the best boat. Their picture will include the different parts of the boat that they believe help it to sail. This will be before the students are given any of the materials they will be using to build their boats. The purpose of this is to just start to think about the different parts of a boat and their functions. **Focus Question:** What makes a good sail on a boat? |
| **Explore** | We can then introduce the activity of them building boats. We will split them into groups and show them all the materials they will be working with (these will be placed on trays for us to pass out to the students.) We will hold a class discussion about what materials would float and sink. We will ask probing questions to get them thinking about what makes boats float. When the students are done discussing this, we will bring them back together as a group, and we will test the materials in the middle of the room, with the students surrounding the water, in order for all of the students to see what sinks and what floats. This will give them a form of guidance, but will still allow them to make their own version of a boat. The students will be told that their end test will be putting it on water, with a fan behind and they will have the goal of it floating all the way to the end. Next, we will have the students break up into partners (we will remind them that this means groups of two), and these will be the partners that work together for the whole process of planning, building and fixing their boats. They will be able to choose their own partners, but if this causes too much disruption, this will be changed, and we will pick their partners for them. Once their boat is built, we will place the boats inside a water filled erosion table backed by a fan and time to see how fast the boat travels from one end to another. This will require both the testing of the buoyancy and ability to sail across the water efficiently and effectively. We will encourage them to focus on weak/strong points of their boats. We can ask them questions such as “What materials worked best for your boat?” “Did anything cause your boat to sink?” “How could you make your sail more effective?” “How does the size or orientation of your sail matter?” After most of the groups have completed their first trial, the whole class will take a break to eat snack.After evaluation and test 1, we will send them back to the drawing board and ask them to either reinforce or build an entire new boat with new knowledge in mind. We will challenge them to use evidence from their first trial to support the changes they made to their revised/new boat. They will then re-test their new boat and have them record whether or not their new boat performed better than their last. This will be on a sheet of paper that the students will leave in the room at the end of their lesson in order for us to evaluate whether or not they understood the material.  |
| **Explain** | Each group will be asked to describe the materials they used that made their boat successful and unsuccessful. Each group will also be asked to share one thing that did not work in their boat, and each group will discuss why this did not work, based on the things we talked about at the beginning about successful sails. We will connect what the students made with basic physics topics. Some questions will be: “How did the amount of weight on your boat impact its ability to float?” “How did the materials you chose affect the friction of the boat against the water?” |
| **Elaborate** | As a lesson extension, we will challenge them to see how many “passengers” their boat could hold before sinking. The passengers will either be pennies or marbles. This will change the focus from “what makes a good sailboat?” to “what makes the best boat float?” We will have the students answer a question on a notecard, such as “What is one material you had on your sail that made it most successful?” or “If you were to do this again, what is an item that floats that you would like to include on your boat?” This will be their “exit” ticket for the week. We are hoping that this stage gets them excited for the weeks to come, and it is a great way to end the conversation for the day.  |

G) How will you determine if your students achieve the objectives for this week?

We will have multiple ways to determine if the objectives were met. These will include the students leaving their planning sheets with us, to look over. We will also be walking around and informally assessing if they are understanding what they are supposed to be doing, and offer guidance during those times. We will also be able to assess the boats that the students created, to see if they were applying the knowledge of what materials sink and what materials float, that we discussed at the beginning of class. In the elaborate stage, we are also having students answer questions on notecards, which will be a fun way for the students to respond with the information that they have learned from the week, and a good way for us to assess what the students learned and focused on for the week.

H) PEDAGOGICAL FOCUS:

Our focus for this lesson is assessing for learning. This week we are assessing for learning in many ways. Our main method of assessment will be through pictures. As we learned in our readings, assessing through student drawings is beneficial for students who are English Language Learners and for students who struggle with social communication. We will be having students draw a picture while planning their boats, draw a picture while making changes to their boats, and draw a final picture of their final boats. We will collect these three pictures to assess for student learning throughout the progression of the activity.

We will also assess for student learning by using the 3C’s - Clarity, Coherence, and Causality. By assessing through clarity, you are assessing the student’s ability to clearly communicate their ideas with others. We will assess this during our Explain section of the lesson where students will be asked to discuss and share their boats with the whole class. When assessing coherence, you are assessing the student’s ability to connect the material they are learning with other ideas, experiences, and evidence. We will assess coherence during our Engage section of the lesson where students are asked to connect what they know about boats with science concepts. Causality is the last of the 3C’s and it is assessed by if a student can form a connection between the cause and effects of the given phenomena. We will assess causality in our lesson by determining if the students understand the connection between how much weight they have on their boats and whether or not their boat floats.

**LESSON #3 -** Projectiles

A) LEARNING OBJECTIVES

* Students will be able to engineer their own functioning projectile that can launch a cotton ball at least 3 feet.
	+ The assessment for this objective will be the the catapult that the students create.
* Students will be able to defend their reasoning and support their idea with evidence.
	+ The students will be talking to their table group about the projectile that they created. They will be promoted, and asked to tell their table group about why they chose that specific design, and must support it with reasoning.
* Students will be able to demonstrate creating a plan and executing it, collaborate, engineering, problem-solving, and defend reasoning.
	+ Evidence of this will be by the end discussion about our focus question, which is, “What is the best way to catapult an object?”

B) TEACHER CONTENT KNOWLEDGE

* Teachers must have a solid foundation on the engineering process. The engineering design process is a series of steps to follow when one is designing something or trying to solve a problem. The engineering process consists of five steps: ask, imagine, plan, create, and improve. You begin by asking a question of something you want solve. You then brainstorm different ideas and plan what you want to do. After planning, you begin to create your idea using a variety of materials. After creating, it is always important to evaluate what you created to see what can be improved.
* Teachers must have a strong grasp on basic physics concepts including force, acceleration, motion, energy, and weight. Force is defined as any interaction that changes the direction of an object. Acceleration is a vehicle's capacity to gain speed over time. Motion is the change of a position of an object over time. Energy has two types: kinetic and potential. Kinetic energy is energy in motion, and potential energy is the energy possessed by an object. Having an understanding of these concepts and definitions will allow both the teachers and the students to better understand what they are making and why it works.

C) MATERIALS

* 300 large pack of Popsicle sticks
* 100 rubber bands
* 5 rolls of scotch tape
* 100 small popsicle sticks
* Hot glue gun/hot glue sticks
* Aside from these, just a variety of different materials for students to add
* 40 cotton balls
* 6 large pieces of cardboard
* Assortment of Water bottle/milk caps(at least 25)
* 45 spoons
* 30 pieces of printer paper
* 30 markers

D) REFERENCES (list ALL references that you borrowed ideas from to develop this lesson – including any handouts you may distribute)

* Google for specific definitions

E) TENTATIVE TIMELINE (Keep brief—tables work well for this!)

|  |  |
| --- | --- |
| 15 minutes  | Introductions, Ice Breaker |
| 5 minutes | Engage: Discussing different types of projectiles and catapults  |
| 10 minutes | Talking about what makes a good catapult/projectile |
| 10 minutes | Brainstorm different designs  |
| 45 minutes(with 15 minutes for snack at 10:30am) | Explore: Create catapults by self, and they will be testing them on the floor  |
| 15 minutes | Reworking parts of catapult/projectile |
| 15 minutes | Elaborate: What would it take to catapult something further? How would you change your catapult/projectile to launch something 15-30 feet? |

\*Bathroom breaks will be included\*

F) DESCRIPTION OF YOUR LESSON:

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| **Engage** | Our ice breaker will be called “toss it.” We will have a beach ball and it will have different questions/prompts written on it. The students will make 2 circles around the room (so that more students are engaged) and they will be tossing it to each other. These will be things such as.. “What is your favorite ice cream flavor?” “My favorite part about the school day is…” etc. As the students are tossing it, they will be answering the question that lands closest to their right hand (we will have everyone hold up their right hand before starting, as a reminder.) We will do this until every kid has had a chance to share once, and then we will switch the groups up and do it again. We have noticed that many of our students only like to share with some of their friends, so we hope this is a way to get everyone up and moving and sharing with more of the class. Our engagement activity for this week will us talking about the history of catapults and the different things that catapults can launch. After we give the students a little history about catapults, such as the first catapult that was used, we will show them our large-scale catapult launching a small ball. <https://docs.google.com/presentation/d/11K882VaVLwjpZ3BZaIZaen2tR8JPL438iDQ_O6quXeQ/edit?usp=sharing> We will then go over the key vocabulary words that we will be talking about are:* Catapults - a device in which tension is released to hurl an object some distance, in particular.
* Tension - the state of being stretched tight
* Force - strength or energy that results in movement
* Motion - the process of being moved
* Potential Energy - the energy that is stored due to its position
* Kinetic Energy - the energy of an object in motion

The students will then make a graphic organizer (a spider web) with the word catapult in the center. The students will then brainstorm different aspects of catapults and write supporting details (how catapults work, etc) in the bubbles. Students will be given blank white paper and will have to draw the spider web themselves. Catapults**Focus Question:** What is a catapult? |
| **Explore** | We can then introduce the activity of them building catapults. We will split them into groups and show them all the materials they will be working with (these will be placed on trays for us to pass out to the students.) We will show the students that they will be testing their catapult with two different tests. The first test will be the length test, to see how far their catapult will go. We will have a grid on the floor to show every 2 feet, so that students can see their goal. Students will do a total of 3 trials. Trial 1: yarn ball, Trial 2: Ping pong ball and Trial 3: a button. Each round students will predict what item will travel further. Their second goal will be the target test, to see if they can make their catapult hit something that is on the wall. We are using a piece of anchor chart paper for this. For the second test, we will be doing it in the hallway, so that the students can have it flat against a wall for their target. The anchor chart has 3 different targets so the students will each be able to try to hit whichever one that they want. After students test their catapults they will encourage them to focus on weak/strong points of their catapults. We can ask them questions such as “What materials worked best for your catapult?” “Did anything cause your catapult to launch higher or farther?” “How could you make your catapult more accurate?” “How does the size or orientation of your catapult matter?” After most of the groups have completed their first trial, the whole class will take a break to eat snack.After evaluation and testing of catapults, we will send them back to the drawing board and ask them to either reinforce or make adaptations to their catapults to either make the distance, height or accuracy better. We will challenge students to use evidence from their first trial to support the changes they made to their revised catapult. They will then re-test their catapults and have them record whether or not their new catapult changes performed better than their last. All of the information and characteristics we discovered will be discussed. |
| **Explain** | After the students have gone through the 3 trials, we will talk to the students about which ball went the furthest, or which one hit the target easier. The answers will be due to their weight and size, but we will probe the students to get here on their own. We will also ask them questions such as, “what is a material that if you catapult, it will not go far?” such as rocks, shoes, etc. And other questions such as “if you made changes on your catapult, what were they? Why did you make those changes? How did it change the outcome?” |
| **Elaborate** | For the elaborate, we will be prompting the students to make a mini-catapult out of only popsicle sticks and rubber bands. This is something we could do with the students, but also allows for them to connect the information that they have learned this week through creating the same thing on a smaller scale.  |

G) How will you determine if your students achieve the objectives for this week?

For this lesson, we will be able to assess student learning many times throughout the lesson. We will be assessing the students through the web that they create for our vocab words that we go through at the beginning. We will be walking the students through creating an actual web, but the information that they have within the web will be our key to whether or not they understood the information. We will also be assessing the information for whether or not they are able to catapult a cotton ball at least 2 feet. This will show us whether or not they understood the idea of how catapults work. If they do not understand, we would expect their catapult not to work. An extension for the students is seeing whether or not they can hit the targets, or a specific target. If they are able to do this, they have excelled at making the catapults.

H) PEDAGOGICAL FOCUS:

Our focus for this lesson is science for ALL with a focus on ELL students. We plan to address science for all learners in our lesson by specifically pulling out the vocabulary words for the lesson and writing them on the board. During the engage of our lesson, we will explicitly go over what each of the vocabulary words mean. Also in our engage, we will have the students fill out a graphic organizer (a spider organizer) to help them grasp the concept of what a catapult is and how it works. This will help to promote science for all learners, and specifically ELL students, because it helps the students to hold onto the vocabulary and develop a conceptual understanding. Another way that we plan to support ELL students with vocabulary is to make use of language stems. After we introduce the vocabulary words and the students make their spider web organizers, we will display a few sentences with language stems on the smart board and the whole class will work together to fill in the blanks.

As always, we will write our focus question on the board. This helps to support ELL students because it guides the students in the direction that the lesson is going. We also plan to make a powerpoint filled with mostly pictures. This is so that students with ELL can understand what the powerpoint is trying to say even if they can not read English. This will help to give the students context about what the lesson is about. Lastly, we planned our lesson around hands-on activities where it does not require a student to read or speak in English. This is especially beneficial to addressing science for all learners because whether the student be ELL, has a learning disability, or just socially withdrawn, each student will be able to participate and learn.

**LESSON #4 -** Roller Coasters

A) LEARNING OBJECTIVES

* Students will be able to engineer their own functioning roller coaster.
	+ The assessment for this objective will be the roller coaster that the students create.
* Students will be able to discuss the concepts of gravity and friction in reference to their roller coasters.
	+ Students will be discussing with their groups how physics concepts go into building and testing the roller coaster. We will be walking around facilitating discussions so we know they are going in the right direction.
* Students will be able to identify the points in their roller coaster where the car (marble) accelerates and decelerates.
	+ Evidence of this will be by the students filling out the Roller Coaster Specifications worksheet.

B) TEACHER CONTENT KNOWLEDGE

* Teachers must have a solid foundation on the engineering process. The engineering design process is a series of steps to follow when one is designing something or trying to solve a problem. The engineering process consists of five steps: ask, imagine, plan, create, and improve. You begin by asking a question of something you want solve. You then brainstorm different ideas and plan what you want to do. After planning, you begin to create your idea using a variety of materials. After creating, it is always important to evaluate what you created to see what can be improved.
* Teachers must have a strong grasp on basic physics concepts including forces, acceleration, energy, speed and weight. Force is defined as any interaction that changes the direction of an object. The two specific forces this lesson focuses on are gravity and friction. Gravity is a force that draws any two objects towards each other and friction is a force caused by the rubbing of two objects. Acceleration is a vehicle's capacity to gain speed over time. Energy has two types: kinetic and potential. Kinetic energy is energy in motion, and potential energy is the energy possessed by an object. Speed is how fast an object is moving. Having an understanding of these concepts and definitions will allow both the teachers and the students to better understand what they are making and why it works.

C) MATERIALS

* Foam pipe cut in half (at least 36 feet, the more the better)
* At least six rolls of masking tape
* 6 marbles
* 6 paper cups
* Yard Sticks
* 24 scissors
* 6 stopwatches
* Markers
* Worksheets

D) REFERENCES (list ALL references that you borrowed ideas from to develop this lesson – including any handouts you may distribute)

* Google for specific definitions
* <https://www.teachengineering.org/activities/view/duk_rollercoaster_music_act>

E) TENTATIVE TIMELINE (Keep brief—tables work well for this!)

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| --- | --- |
| 15 minutes  | Science Bingo |
| 10 minutes | Engage: Discussing vocab and roller coaster basics |
| 10 minutes | Explore: Begin planning roller coaster |
| 10 minutes | Make first model of roller coaster and test |
| 15 minutes | Snack (around 10:30) |
| 45 minutes | Go back and make changes to the roller coaster, test, and repeat until the roller coaster is functional and meets the standards. |
| 15 minutes | Explain: students will all share their roller coasters and we will go over science concepts |
| 15 minutes | Elaborate: Roller Coaster recording sheet and application of vocabulary |

\*Bathroom breaks will be included\*

F) DESCRIPTION OF YOUR LESSON:

|  |  |
| --- | --- |
| **Engage** | Our ice breaker for this week will be playing Science BINGO, as this will allow the students to work alone to complete the activity. We have tried group ice breakers, but they have trouble working in big groups for fun activities, so having them work by themselves to start will be a good opening activity. This has our vocab words on the BINGO sheet, and in order for them to win, they have to define 2 of the words that are on their BINGO. In order to help the students, we will be going over the words as soon as they come up, so if the word “motion” comes up, we will stop them and define is as, “the process of being moved.” To engage our students this week, we will show them the video, <https://www.youtube.com/watch?v=znVn3oSnqeY> , which shows someone going on a roller coaster from the rider point of view. This will hopefully get the students thinking about roller coasters, which will be a perfect leeway into our actual activity for the day. We will then go over the key vocabulary words that we will be talking about are:* Acceleration - How quickly an object speeds up, slows down or changes direction
* Friction - a force caused by two objects rubbing together
* Speed - how fast an object moves
* Potential Energy - the energy that is stored due to its position
* Kinetic Energy - the energy of an object in motion

As we go through the vocab words, we will be writing the definitions on the board for reference. This will also be used during our explain portion of our lesson.**Focus Question:** How do engineers build successful roller coasters? |
| **Explore** | We can then introduce the activity of them building roller coasters. We will split them into random groups based off of what index card they pull from a deck. We will introduce the students to the competition part of the activity, giving them the different criteria they should be including in their designs. Points will be given based on the inclusion and number of:* Number of loops
* Number of corkscrews
* Number of turns
* Acceleration points
* Deceleration points
* Points of potential energy
* Points of kinetic energy

With the criteria in mind, students will be prepared to include all these things in their blueprints. Students will individually draw blueprints of their ideal roller coaster then share them as a group. Then in an attempt to ensure each student makes a contribution, they will need to include at least ONE aspect of each students’ blueprint in the final product. This will hopefully help teamwork dynamics and will eliminate students being excluded.Once students have a new, group-approved blueprint, they can begin building. We will hand out the pre-divided materials to make sure each group gets an even chance when building their roller coaster. Because they won’t be given a marble right away, we assume this first round of construction will be rather quick. Once they’re ready, they will test their roller coaster. After the first round of testing, students will go back and add improvements to make sure there are no exit points for their marble. For this second round of construction, they will be allowed to keep a marble for testing purposes. This process should take significantly more time as they will now be forced to focus on points of acceleration/deceleration and potential/kinetic energy.After students seem to be wrapping up their final product, we will test their roller coasters officially for a second time. For this part, we can have the entire class watch each group’s trial to see what worked best and what needed improvement. We will hold a class discussion on these observations the students make while watching their peers’ roller coasters being tested. |
| **Explain** | After the students have created their roller coasters, and tested them, we will be talking about why certain parts of their roller coasters worked, and what parts of their roller coasters they had to fix. During this time, we will be bringing back up the vocab words, and talking about what aspects made their roller coaster successful. Each group will be required to talk about one vocab word that we discussed at the beginning, which will be posted on the board, for them to reference back to. An example of this would be one group saying, “the acceleration of our marble on the initial drop was what carried it through the rest of the coaster.”  |
| **Elaborate** | For the elaborate, we will be prompting the students to complete a worksheet to elaborate on the different characteristics of their • Place a 1 next to a point on your roller coaster where the cars accelerate. • Place a 2 at a point on your roller coaster where the cars decelerate. • Place a 3 next to the point where cars have the greatest potential energy. • Place a 4 next to the point where cars have the greatest kinetic energy. This will be highlighting and reiterating several key terms that we introduced in the bingo game. If time allows we will have students share with the whole group key parts of their rollercoaster and demonstrate it to the class. |

G) How will you determine if your students achieve the objectives for this week?

For this lesson, we will be able to assess student learning many times throughout the lesson. We will be assessing students by prompting them to have trials with their roller coasters. We will see evidence of student learning through the implementation of ideas they constructed in the engineer process. We will incorporate vocabulary and promote the use of it in explaining how and what part of the roller coaster works. For example we need to adjust our drops to generate more kinetic energy to accelerate the marble in order for it to successfully make it around the loop. We will be moving around from group to group to engage students in these conversations as well as having a group conversation to wrap up the day. After the explain phase we will use the worksheet that we had each student use to reflect to have a group discussion.

H) PEDAGOGICAL FOCUS:

Our pedagogical focus of this lesson is STEM integration. STEM stands for science, technology, engineering and math. We plan on integrating STEM into our lesson by letting the students take the lead on the lesson. A lot of the activities we chose, such as building the roller coaster is based around giving students a variety of materials and allowing them to use their creativity to build their roller coaster. The S is STEM stands for science. We will integrate science into this lesson by covering the concepts of acceleration, friction, speed, and potential and kinetic energy. The T is STEM stands for technology. We will integrate technology concepts in this lesson by showing the students a short video on the computer of a roller coaster stimulation. The E in STEM stands for engineering. We will integrate engineering into this lesson by utilizing the engineering design process. The M in STEM stands for mathematics. We will integrate math in this lesson by having the students measure their roller coasters and understand the different angles that their turns are functioning at. Some people emphasize STEAM instead of STEM where art is also included. We will include art in our lesson by having the students draw pictures to plan their roller coasters as well as encouraging the students to be creative by giving creativity points.

Day of materials:

* Meter sticks
* Foam runways
* Wooden sticks
* Styrofoam pieces
* One adult scissors

Rube Goldberg Example Video:

https://www.youtube.com/watch?v=OHwDf8njVfo

**LESSON #5 -** Rube Goldberg

A) LEARNING OBJECTIVES

* Students will be able to engineer their own functioning Rube Goldberg Project.
	+ The assessment for this objective will be the project that the students create.
* Students will be able to discuss the concepts of gravity and friction in reference to their Rube Goldberg project.
	+ Students will be discussing with their groups how physics concepts go into building and testing the Rube Goldberg project. We will be walking around facilitating discussions so we know they are going in the right direction.
* Students will be able to identify the places in their product where a transfer of energy occurs.
	+ Students will fill out a diagram at the end of the lesson where they will be able to label this and discuss with their group members.

B) TEACHER CONTENT KNOWLEDGE

* Teachers must have a solid foundation on the engineering process. The engineering design process is a series of steps to follow when one is designing something or trying to solve a problem. The engineering process consists of five steps: ask, imagine, plan, create, and improve. You begin by asking a question of something you want solve. You then brainstorm different ideas and plan what you want to do. After planning, you begin to create your idea using a variety of materials. After creating, it is always important to evaluate what you created to see what can be improved.
* Teachers must have a strong grasp on basic physics concepts including forces, acceleration, energy, speed and weight. Force is defined as any interaction that changes the direction of an object. The two specific forces this lesson focuses on are gravity and friction. Gravity is a force that draws any two objects towards each other and friction is a force caused by the rubbing of two objects. Acceleration is a vehicle's capacity to gain speed over time. Energy has two types: kinetic and potential. Kinetic energy is energy in motion, and potential energy is the energy possessed by an object. Speed is how fast an object is moving. Having an understanding of these concepts and definitions will allow both the teachers and the students to better understand what they are making and why it works.
* Teachers must have prior knowledge of Newton’s 3rd Law - every action has an equal and opposite reaction.

C) MATERIALS

* At least six rolls of masking tape
* 6 marbles
* 6 paper cups
* Yard Sticks
* 24 scissors
* 6 stopwatches
* Markers
* Worksheets
* Cardboard
* Cars
* Popsicle sticks
* Golfballs
* Wiffle balls
* Ping pong balls
* Toy cars

D) REFERENCES (list ALL references that you borrowed ideas from to develop this lesson – including any handouts you may distribute)

* Google for specific definitions

E) TENTATIVE TIMELINE (Keep brief—tables work well for this!)

|  |  |
| --- | --- |
| 15 minutes | Engage: Discussing vocab and Rube Goldberg history and examples |
| 10 minutes | Explore: Break up into groups and begin planning Rube Goldberg  |
| 10 minutes | Begin engineering Rube Goldberg  |
| 15 minutes | Snack (around 10:30) |
| 45 minutes | Continue working on Rube Goldberg while testing throughout |
| 15 minutes | Explain: Have the students share their projects and tie it to content knowledge (define energy transfer) |
| 15 minutes | Elaborate: Complete activity assessing and comparing knowledge and parts of Rube Goldberg |

\*Bathroom breaks will be included\*

F) DESCRIPTION OF YOUR LESSON:

|  |  |
| --- | --- |
| **Engage** | To engage our students this week, we will show them various videos of example Rube Goldberg completed projects, and they will be able to see their goal end result. These videos will be: <https://www.youtube.com/watch?v=ICv5owYrW4w><https://www.youtube.com/watch?v=OHwDf8njVfo>We will show these videos and then talk about a few options that the students will have to choose from including: hitting a balloon, getting a ball into a cup and hitting a tuning fork. We will also introduce the different materials that we have, and go over the process to get their materials. This will include the materials being on the back table, just as they were last week, and the process to get their materials (which is just asking a teacher to ensure nothing breaks or falls.) **Focus Question:** How do engineers build successful Rube Goldberg projects?  |
| **Explore** | We can then introduce the activity of them building Rube Goldberg.We will have the kids lineup and number off 1-6 to get into groups. Once in groups kids will have to decide on what objective their Rube Goldberg will serve. With the criteria in mind, students will be prepared to include all these things in their blueprints. Students will individually draw blueprints of their ideal Rube Goldberg then share them as a group. Then in an attempt to ensure each student makes a contribution, they will need to include at least ONE aspect of each students’ blueprint in the final product. This will hopefully help teamwork dynamics and will eliminate students being excluded.Once students have a new, group-approved blueprint, they can begin building. We will give them the goal of including 4 points of energy transfers (at this point they will think of this as ‘steps’). We will hand out the groups end result that they chose (if a group chose hitting a balloon, we will hand them their blown up balloon). We assume this will take them quite a while to create their final project, but since they are able to continually test their product, we believe they will be able to create really cool end projects. After students seem to be wrapping up their final product, we will have each group test their final product two more times and then set it back up for the whole class to walk around and see. Last week, our students liked seeing each others roller coasters, so giving them the chance to see everyone Rube Goldberg’s projects would be fun for the kids.  |
| **Explain** | After the students have created their Rube Goldberg and tested them, we will be talking about why certain parts of their device worked and what parts they had to fix. During this time we will be bringing back up the vocab words from the previous week. As a class, we will discuss what aspects made their device successful. Each group will be required to talk about one vocab word that we discussed at the beginning, which will be posted on the board for them to reference back to. “What did you notice worked best?”“What didn’t work well the first time?”“What changes have you made after the first round of testing?”“Where are points of potential and kinetic energy?”“What materials worked best?”“Where are your different steps?”“What happened after each step?”This will also be a good time to define what a “transfer of energy” is and how they can identify them in their devices. We can have them explain the various steps in their device and relate that to a transfer of energy. |
| **Elaborate** | For the elaborate, we will be prompting the students to think about the places in their Rube Goldberg project where the energy was transferred. The students will be getting a worksheet where they are to draw their final Rube Goldberg and they will be labeling the spots on their worksheet where the energy was transferred. The goal that the students have is to have created 4 different places where energy was transferred, so this worksheet is a great way to observe whether or not they completed that, and also a way for them to look at their final project in a different light. They will be working on their worksheets alone and then comparing them with their group members to see if they ended with the same results of energy transferred.  |

G) How will you determine if your students achieve the objectives for this week?

We will assess student learning several times throughout the day by evaluating whether or not their machine is functional and the discussions they are having. We will also have students identify at which places energy is transferred. Discussions during and afterwards will help us gage student knowledge on energy transfers, action and reaction, etc. student learning many times throughout the lesson. We will be assessing students by challenging them to make changes. We will see evidence of student learning through the implementation of ideas they constructed in the engineer process. We will incorporate vocabulary and promote the use of it in explaining how and what part of the Rube Goldberg works. For example we need to adjust our drops to generate more kinetic energy to accelerate the marble in order for it to successfully make it around the loop. We will be moving around from group to group to engage students in these conversations as well as having a group conversation to wrap up the day. After the explain phase we will use the worksheet that we had each student use to reflect to have a group discussion.

H) PEDAGOGICAL FOCUS:

For this lesson, our pedagogical focus is science for all with a special education focus. We plan to integrate science for all with a special education focus in many places of our lesson. We plan to have students work in groups which will create an environment that supports student success by combining multiple ideas and provides assistance for construction tasks. As well, we will help students document their ideas by encouraging them to draw pictures rather than using words. This helps students who struggle with written communication. A big part of tailoring lessons for students with special needs is to provide scaffolding for spatial tasks. To do this, we will present the engineering problem in 3D by making a physical example of a rube goldberg along with showing the video examples. We may also have to help the students build. From our knowledge, we do not have any students who classify under special education, but the strategies to benefit special education students can also benefit all students.