Unit Title	**Getting Your Feet Wet With MOSS - Reverse Engineering**
Grades/Ages	Ages 8 to 11 (Grades 3-5)
Hello!	**The purpose of this unit is to introduce students to MOSS through the excitement of discovery. By exploring MOSS robots and everyday objects through reverse engineering, students (and teachers) become more comfortable with robotics foundational concepts by playing with and deconstructing whole robots and items. We will explore constructed robots and objects and, by gradually disassembling them, students will begin to discover the functions of MOSS components. This non-intimidating unit is an ideal way to start out with working with robots. There are many who are reluctant to explore robotics at first, believing that in order to understand it, it is necessary to have a background in technology and programming; this is not the case at all with MOSS or Cubelets. In this unit, you will have the opportunity to introduce students to this exciting and innovative tool and plant the seed for more in depth applications over time.** When I began my work as a STEM teacher in 2012, I entered this arena without any background whatsoever in engineering, programming or technology-- but with the boundless enthusiasm, drive, and natural curiosity to learn it. What inspired me most in becoming a STEM specialist was to have the opportunity to provide children with the chance to recognize their passions and follow them. To be their guide and facilitator as I provide them with support, respect and resources to challenge themselves and to bring their learning, their enthusiasm and their curiosity to new levels. Levels they could never have imagined before, ones that give license to become the great innovators that we need in the world. Several years ago when I began my work in elementary STEM, we were really at the beginning stages of what has since broadened to reach educators of all backgrounds. As a newcomer to this growing field I spent a great deal of time researching existing ideas, resources and innovative approaches to guide me in my new role. At first I found the offerings to be a bit limited. I found many an approach to how to best teach the engineering design process through an Egg Drop unit, and lessons on designing parachutes and spaghetti towers were plentiful. It was when I first learned of Cubelets and, soon after, MOSS that I found a STEM resource that was not a limited or limiting experience for students but rather a 21st century tool through which I could provide challenging and exciting learning experiences while integrating robotics in every aspect of the curriculum. It's been a very exciting journey. When I first met Cubelets, I loved the look and the nature of them; chunky blocks with vibrant colors, magical magnets snapping together. Building with blocks that could come to life. The child in me, who actively leads me and is my teacher from within, was immediately mesmerized. Blocks, play, colorful patterns-- that all seemed so natural. The adult mind--with its doubt, hesitancy, and skepticism-- worried a bit. What do *I* know about robots? I challenged myself. Knowing

	that inside of each Cubelet lived little electronic doo-dads constructed by elves in the far away land of Boulder intimidated me. How do they work? How does the magic happen? The unknown seemed to hold many rules in my mind and I wasn't sure where to begin. And with that my back and forth began. Intrigue and delight conflicting with old feelings of fear and apprehension of what I had convinced myself I could not do. The mystery is what intimidated me and at the same time what intrigued me. Wrapping my head around it meant letting go and not diving in but stepping in, a little at a time. Small steps...getting my feet wet, alongside my students, not always in front of them. Knowing that as a teacher, I do not have to assume the role of the all-knowing leader, I can harness and be led by my curiosity and interests and with that ignite that same spark of discovery within them. I found that learning how to work with Cubelets and MOSS *alongside* my students and organically exchanging roles of teacher and student provides my students with some of the most meaningful, memorable and empowering learning opportunities I have ever experienced as an educator. Come join me in this journey of discovery alongside our students. I'm excited to see where it will take us all to next. Your Teacher Friend, Beth.

The Work of an Engineer:

Students will review what an engineer is and the steps of the engineering design process. They will complete the challenge of designing and building a "Sphere Keeper" to be used to keep the metal spheres in place when working with MOSS Robotics Construction System.

Students will learn that engineers are problem solvers who have goals beyond solving problems. Their work fulfills the needs of our society and, with that, their work also branches out into the social sciences and the arts. These concepts will provide important background information our next lesson in reverse engineering. The activities in our Opening Activity Set can be taught as best suits the needs of each classroom. Some teachers will choose to teach each part in one class period consisting of four periods total while others may group two parts together. While an estimated amount of time is given, teachers may adapt the length of time to scheduling needs.

Activity: Engineers are Problem Solvers

Estimated Time - 45 minutes

"Today we are going to take a look at some of the work that is done by engineers. What is an engineer?"

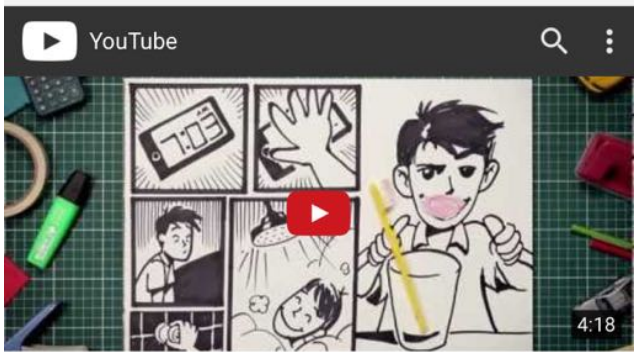
Students who have had background lessons in STEM and engineering should respond by saying that **engineers are people who design products, structures or systems to improve people's lives. They do so in order to solve a problem or fulfill a want or a need.** Those with less experience in the area may say that an engineer fixes things like computers or cars, not realizing that would be a technician. Some might say an engineer drives a train. The opportunity to reinforce understanding of this definition will come through viewing the upcoming video.

"*What does it mean to design something?" (students share their ideas as to what design is)*

"Yes, design is the process someone uses to create things by using a plan.An engineer is a problem solver, just like all of you are. You solve problems in school all the time, sometimes in your class work like in math or science. Other times it might be a problem that you are faced with at recess with your friends. An engineer is someone who looks at our world and defines a problem. Then, using the ***Engineering Design Process****, an engineer imagines or brainstorms a variety of solutions to the problem, plans solutions, creates a final product, tests it and then determines ways that the product might be improved upon.The solution can be a new form of technology, a system a structure or an environment.*

In the video we are about to watch, I'd like you to watch for some of the different ways in which engineers solve problems.You will notice products, structures and systems that you see and often use in your daily life. While you are watching, think about ways in which engineers have worked

to design solutions to a problem. See if you learn about anything that you find surprising. "



*Show video. "What is Engineering?" by UON FEBE (*Youtube)*

" In the video, we learned about some types of engineering and the kinds of problems engineers solve. Were you surprised to learn about some of the products, structures and systems that engineers work on? What surprised you the most? (Students respond, teacher captures responses on a class chart with the heading "Engineers Designing Solutions".

At the end of the video the narrator asks the viewer 'What problems do you want to solve? On your worksheet "Designing Solutions" (Worksheet 1) *illustrate a problem you would like to solve and your idea for a possible solution. When you have completed your illustration, write to explain your ideas. We will hang them in our 'Engineering Solutions Gallery' (*teacher designates area in classroom for display). *We will display your Engineering Solutions and then have a gallery walk to share and discuss everyone's innovative ideas."*

Once Designing Solutions work is displayed, gather students in 'gallery". Teacher conducts a "tour' and describing the problems and solutions and conducts a class discussion during this tour.

"*So now you have a better understanding of who an engineer is and what is involved in the job of an engineer. Tomorrow we will take a look at another area of engineering that we have not yet addressed - the engineering of robots!*

Activity: The Sphere Keeper Challenge - Defining the Problem, Criteria and Constraints

Estimated Time - 45 minutes

Yesterday we had the chance to learn about engineers as problem solvers and we shared our ideas on possible solutions to existing problems. We had a lot of fun and very interesting discussions about these innovations during our Gallery Walk!

*Let's take a few minutes now to look back at the chart we created after watching our video yesterday in order to remind ourselves about the different types of problems and solutions that different kinds of engineers work with (*review "Engineers Designing Solutions" chart).

Next we will take a look at another area of engineering that we have not yet addressed - the engineering of robots. From what we have seen and discussed so far, what kind of an engineer do you think designs robots? (teacher allows for students share ideas) Actually, there are several types of engineers who can make up the team that creates a new robot construction system. They might be mechanical engineers, electrical engineers or software engineers."

*For the next part of this lesson students will be working with "Engineering Teams" of 3 or 4 students which they have been grouped in ahead of time. The teacher might choose to vary grouping strategies depending upon the situation and needs of the group working on this activity.. Some teachers choose to group according to the Kagen principles of Cooperative Learning, whereas others might choose to group students with similar ability levels in order for the teacher to provide support rather than the support system being intrinsic within the group.

Teacher holds up MOSS kit. "*This week we will begin our work with MOSS Robot Construction Kits. . You will have several opportunities to explore the engineering design behind MOSS while you learn some exciting new skills in robot construction! I'm really looking forward to seeing all that you will learn!*

Teacher shows students MOSS in Motion Video located on the MOSS home page.

"*What do you think of the MOSS robots you saw in the video? (*Students respond). *As you can see, MOSS robots are built by connecting blocks with metal spheres. The spheres connect to the magnetic corners of the blocks which allows the person working with MOSS to create an infinite number of robots quickly! As I mentioned before, the spheres are not magnetic, it is the corners that are. The spheres are slidy, roly poly round metal objects that typically don't like to stay still until they have reached their ultimate purpose, in connecting MOSS blocks. This can be a bit of a challenge when building with MOSS. Some people put the spheres on a tray with raised edges or in a bowl. That will keep them from rolling away but they can still roll around on the tray or in the bowl (*teacher holds up examples of tray or bowl).

*Today are going to begin our plans for the Sphere Keeper Challenge. On the table in front of me I have a variety of materials that we will use to create our solution (*paper plates, cardboard, magnets, plastic, trays, felt, fabric, modeling compound such as Model Magic that can be air dried, recycled materials, markers for decoration).

Now YOU are the engineer. As we have discussed, engineers work with plans to create a solution. You will work with your engineering team to design and create an invention that will keep your spheres in place when we work with our MOSS robotics construction kit.

*Let's take a look at the worksheet in front of you. (*Teacher shares **Worksheet 2** as example with the whole class on screen*) This will guide you through the **Engineering Design Process**. As you know, the Engineering Design process is flexible. What do I mean by that? (*students respond). *That's right, engineers do not always go through every one of these steps when designing a solution. It is a process that they follow an they choose to use the appropriate steps as needed.*

*The first step in the Engineering Design Process is to "**Ask**" what problem is being solved. This is where we first need to define the problem What is the problem that we are looking to create a solution for today? On the worksheet in front of you, take a moment to define the problem."*

Teacher gives students a moment to complete his or her individual problem statement then calls on students to share ideas. As a class, students will look for common vocabulary in their problem statements such as "still", "stable", "slippery", etc. and create a class problem statement. Teacher fills in response examples for class to see.

"*Yes, the problem is that we have roly poly spheres that need to stay in one place while we work with the MOSS Robot Construction Kit. Please check that you have completed the "Ask" portion on your EDP page. Make any additions or changes that you would like to and give me a thumbs up once you have.* (teacher waits for students to complete this portion of the worksheet)"

"*The next step in the Engineering Design Process is to "**Imagine"** or brainstorm possible solutions to the problem or goal.*

We have provided Worksheets 3 and 4 as additional options to give students the opportunity to explicitly state the problem, criteria and constraints. It is not necessary to use both with your students, although you may choose to do so in order to reinforce the concepts

Students then complete the worksheet(s) along with teacher who completes a class master list. .
*In this step you will imagine possible solutions to the problem keeping in mind specific **criteria** and **constraints.***

For this step we are now going to take a look at the "Design Brief" page in your packet. Please write the problem statement for this design challenge on the first four lines underneath where it says "Define the problem".

*Next we will move on to the Criteria for our design challenge. **Criteria** are the characteristics of a successful solution. **Constraints** the limitations you have in solving the problem. Constraints can include the amount of time, materials, number of people able to work on a project. Teacher shares real life examples of constraints. One possibility that students can easily relate to would be the constraints or limitations for children going on a ride at an amusement park or carnival.*

Teacher and students now work together to define the criteria and constraints for the Sphere Keeper Design Challenge. Students complete their "Design Brief" pages while teacher completes model of worksheet for all to see.

"*We will go back to our EDP Planning page in a few minutes. Now let's take a look at Worksheet 5, the "Solution Sketch Zone". We have defined the problem, criteria and constraints for our challenge (*teacher points out problem, criteria and constraints) *and I'm sure you have had some ideas of possible solutions while we've looked at our materials and had our discussion. Well here we go! Your "Solution Sketch Zone" is your personal brainstorming page. This is where you will put on paper your top one, two or three ideas for possible solutions. This is not the team brainstorm. The team brainstorm will be a part of tomorrow's lesson where as a team you will share your personal brainstorms and collaborate on ideas. So for the remaining time today, you are going to sketch your ideas as a diagram - be sure to label the parts of your drawing as well as listing the materials you plan on using for this solution.Any questions?"*

Teacher responds to questions and students complete worksheet page.

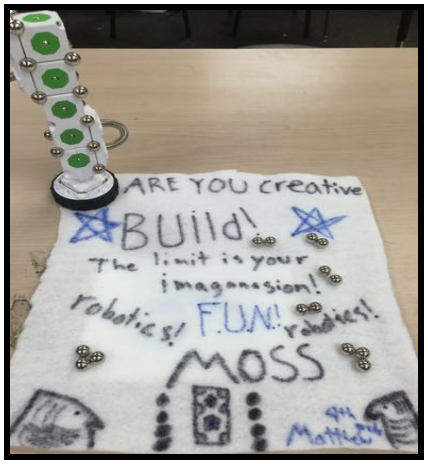
Activity: Engineering Teams Creating Solutions

Estimated Time - 45 minutes

"So far in our unit we have learned about the work of engineers and how problems are solved according to specific criteria and constraints. When we left off yesterday, you were all working very hard to develop your ideas for solutions to our engineering design challenge. In front of you is your "Solution Sketch Zone" worksheet. For the next five minutes you will each share your ideas for solutions with your teams. While everyone is sharing, begin to keep to think about which solutions you believe will best fulfill our goal in building successful Sphere Keepers.

Now it is time to take the next step towards creating our solution. We are going to collaborate as teams and work to determine which of your three most suitable solutions will be the one your choose to create. Let's take a look at the "EDP Imagining Solutions" Worksheet 6 in your packet. This is where we are going to jump right in with our creative thinking as a team. The Imagining Solutions page will serve as our brainstorming area with our teams. As you can see, this chart asks you to think about what is expected of the solution. Vertically, along the left side of the chart, you are asked to list three criteria for this challenge. Please take a moment to do so now." Once students have written the criteria on this chart move on to the next part.

"*Now Sphere Keeper Engineers, it is your turn to be MOSS innovators. You are going to create a product, structure or system that will keep spheres in place when you build amazing robots with MOSS. In your team you are going to brainstorm possible solutions and then agree upon one that your team will create and test. Before we get started I will share with you some examples of Sphere Keepers that have been designed by other students. The students completed all steps in the Engineering Design Process in order to create these successful solutions. The Sphere Keepers pictured below have been created simply by using felt fabric and markers for design. Our designers quickly saw this as a very reliable and convenient solution. The texture of the fabric keeps the spheres in place and these Sphere Keepers were a great deal of fun to create!*



The following are video interviews with some Junior Engineers who came up with three very

different and again very successful solutions. These are provided to demonstrate the exciting variety you will encounter with this challenge. While students all have the same goal, we can learn a great deal about their learning styles as well as areas of interest. You may choose to share these examples with students however seeing them before completing the challenge may disrupt their own creative thought processes.

Videos

The Sphere Keeper Felt Mat in action!

Video

A Sphere Keeper with MOSS blocks in the design!

Video

A traveling Sphere Keeper and a lesson in French and research!

Video

A Sphere Keeper, a game and a supply storage system!

Video

"Once your team has come to an agreement as to which solution your will create, you may come to our materials table to shop for the materials that you will need. In order to receive your materials, you will first submit your plan to me for approval. I will be checking to see that you are working within the constraints of the challenge with an appropriate focus upon the goal. Any questions before we begin?"

Teacher will now respond to questions. Once all questions have been answered, teams will fill in the chart on the EDP Imagining Solutions worksheet. They will then gather their materials, create their solution and then test and share their solution using MOSS spheres.

We would love to see the Sphere Keeper solutions that your students come up with! Share your creations on our Facebook page, Twitter and Instagram with #spherekeeper. We can't wait to see what your students create!

VOCABULARY: technology, engineer, invention, brainstorming, product, structure, system, prototype, design, engineering design cycle, criteria, constraint, collaborate

Designing Solutions Worksheet 2

In the space provided below, illustrate a problem you would like to solve and its solution. When you have completed your illustration, write to explain your ideas.

Problem	Solution

A problem I want to solve is

_____

_____

I could do this by designing a _____(product, structure or system)

My solution is

_____

_____

_____

EDP Imagining Solutions Worksheet 6

Write your design requirements and possible solutions. Then use the following number scale to rate each solution against each of the requirements and criteria (Meets the requirements = 2, Somewhat meets the requirements =1, Does not meet the requirements at al = 0). Total the points for each solution to choose the design you will create.

Design Requirements and Criteria	**Solution #1**	**Solution #2**	**Solution #3**
Your requirement #1			
Your requirement #2			
Your requirement #3			
Total Points			

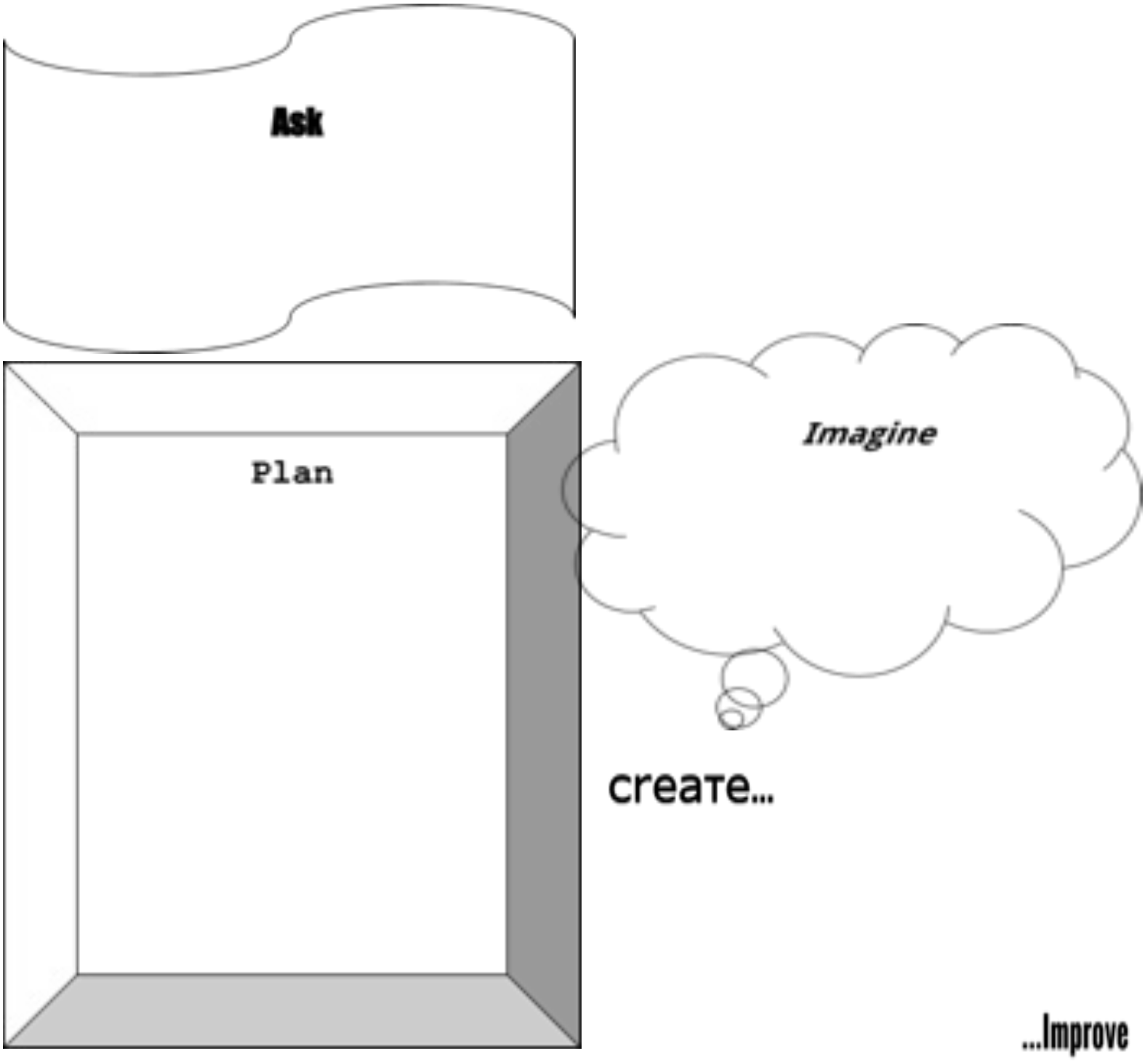
Solution Sketch Zone

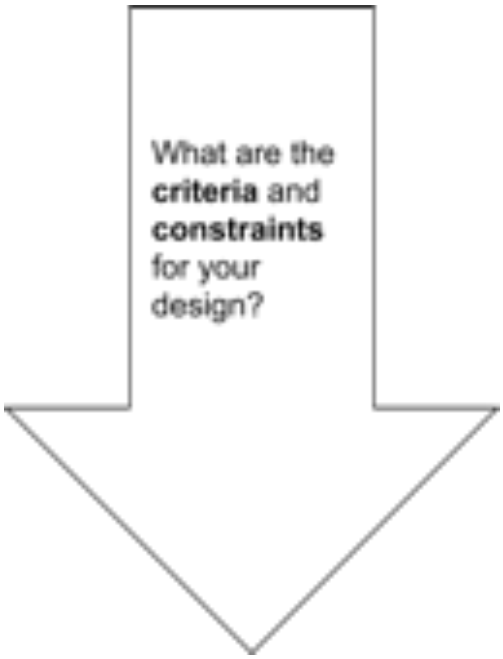
Worksheet 5

This is your personal brainstorming area. After looking at the available materials sketch one to three possible solutions for our Sphere Keeper Challenge. Circle the solution you think best meets the criteria and works within the constraints of this challenge. Share with your team.

Solution #1	Solution #2	Solution #3

Sphere Keeper Challenge





Criteria	Constraints

Design Brief

Defining the problem, criteria and constraints will help to guide you in designing a solution through the engineering design process.

Define the problem:

The problem is what drives the engineer to design the product, structure or system.

_____

_____

_____

_____

List the criteria:

Criteria are things the product must do or include.

_____

_____

_____

_____

Constraints:

Constraints are the limits placed on the resources used to create the solutions.

_____

_____

_____