Members of your Team: _____

Problem:
The World Robotic Basketball League's top ranked team, the BOTS are looking for the best free-throw player they can find. Tryouts are today!

You Are the Engineer!
Design and build a "robot" basketball player that can shoot three free-throw shots accurately each time. The player that is the most accurate will be signed to the team! Your design team has been provided with some "building materials" by your teacher. You have a ruler, glue, tape, paper or plastic cups and plates, cardboard, scissors, paper, pipe cleaners, craft sticks, straws, clips, rubber bands, wire, skewers and clay. Once construction of your robot basketball player is completed, the teacher or "engineering manager" will allow groups to move to the Testing Zone to test their robot basketball player. Design teams must record how accurate (did you make the basket) and precise (how close) the three shots were from the basketball hoop. Each student group will evaluate the results, complete an evaluation/reflection worksheet, and present their findings to the class.

A. Practice Shot: Warming Up

Start by meeting with your team and devising a plan to build your basketball player. You'll need to figure out which materials you want to use (you don't need them all!)

Draw your robot basketball player in the box below:

Predict the % accuracy of your three shots: _____%

B. Pre-Season Training Camp

Build your robot basketball player. During construction you may decide to use additional materials or that your design needs to change. Then, you will test your player in the Testing Zone.

C. Try-outs

Each team will test their robot. If your design was unsuccessful and time permits, redesign and test again.

Team Name	Accuracy % (x/3*100)	Precision (Yes, Somewhat, No)

D. Evaluation Phase

Evaluate your teams' results, complete the evaluation worksheet and present your findings to the class.

1. What went well?

2. What didn't go well?

3. What did you like best about your "Robot"?

4. If you had time to redesign, what changes would you make?

5. What designs or methods worked well for other teams?

6. Why might engineers need to adapt their original plans during the manufacturing process?

7. Do you think you would have been able to complete this project more easily if you were working alone? Explain…

8. What does this tell you about science and engineering systems in the real world?

Teacher-to-Teacher Notes

Materials:

- Basketball (borrow from PE or bring your in your own)
- Ping Pong Balls (enough for each group to have at least one per group – three max)
- 2 student sheets per group
- Construction Materials (provide 2-3 of each item for each group of students to design; allow students to conduct 2 trials – if material and time permits)
    - Paper, foam or plastic plates (various sizes)
    - Paper, foam or plastic cups (various sizes)
    - Cardboard (different sizes)
    - Plastic spoons
    - Rulers
    - Pipe cleaners
    - Craft (popsicle) sticks
    - Straws
    - Binder and paper clips (all sizes)
    - Rubber bands
    - Glue/Tape
    - Craft wire
    - Skewers
    - Clay
    - Scissors
    - string/yarn
    - Paper or construction paper
    - Markers

If your classroom does not have enough materials and needs to ration the items, feel free to place a limit on the amount of each item they can use. For example – students must build a robot using 3 plates, 1 paper rolls, 3 pieces of string, 2 plastic spoons, etc…

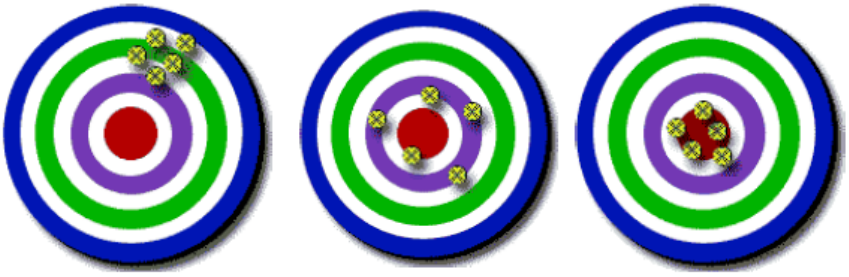
Pre-Lab:

1. Copy enough student sheets for students to have at least 2 per group.
2. Gather materials. Place 1 of each of the construction materials on a tray (under the ELMO or on the table), on a slide shown on the projector or place materials in the center of the work area per group. These are the materials the students can choose to design their robot basketball player. These will not be the items they use to build. They are a sampling of what students may choose from. Students will gather their materials after showing the teacher their design. They do not have to use all the items.
3. Place 1 ping-pong ball in the center of their work area. This ball will be used to "test" their design.
4. Set up the "testing zone" with a "net" by taping a cup down on a desk with a piece of masking tape on the floor 6 feet away. Have the three testing ping-pong balls in a cup at the starting line. Another set up option is to tape the cup "net" up to the wall (about 2 feet from the top of the desk) and place a desk about 6 feet away.
    a. To increase difficultly – use different sized cups as the net (smaller = difficult)
    b. Use masking tape to mark the spot on the floor where the ball lands. Mark the tape with the team number.
    c. Decorate the 3 official ping-pong balls like a real basketball – to make it more fun.
    d. Create "half court" in your classroom – using design of the free-throw lines
5. Create a class table on the board or on chart paper to record each team's score.

	Accuracy (x/3*100) 33%, 67%, 100%	Precision (Yes, No, Somewhat) Note: have teams draw a sketch
Team 1		
Team 2		
Team 3		
Team 4		
Team 5		

Note: The sketch would resemble the bulls eye illustration (where the bulls eye is the hoop)

Examples of Precision and Accuracy:



Low Accuracy
High Precision

High Accuracy
Low Precision

High Accuracy
High Precision

Pre-Discussion (at the end of class, the day before or as an introduction on day 1)

1. Hold up a basketball and ask:
    a. How many of you have ever played basketball?
    b. What types of shots do players have to make? *(mid-range, layup, three-pointer, dunk, alley-oop, half-court and free-throw)*
2. Ask a student to demonstrate a free-throw show by throwing a crumpled up piece of paper into the garbage can 6 feet way. Point out the motion of the arm specifically from the elbow to the hands.
    a. Ask, "What simple machine does this part of the arm look like to you?" Answer: lever. If students don't have prior knowledge of simple machines, you may want to show illustrations of the types of simple machines to help students answer this question.

During:

This lab may take more time than recommended below. Feel free to extend this activity over two or three days. Day 1 – students design and build; Day 2 and/or 3 – students/teacher test and retry their design (if time/materials permits), then close the lesson.

1. Place in groups of 3 - 4 students.
2. Pass out the student sheets. Go over the problem and "You are the engineer" sections with the students. Explain what they have on their tables and their goal for this class period. Make sure to address/revisit the motion of the arm during a shot. Remind students that, in order to make the team, the "robots" must be 100% accurate (successful shot 3 times)
3. Choose two students to demonstrate the difference between accuracy and precision. Have one student shoot a piece of paper from 6 feet away from the garbage can 3 times. The other student will mark where the paper lands with masking tape (if the student misses the basket).
    a. Calculate **accuracy** by dividing the number of made baskets by the number of

shots. Then multiply that number by 100 to get a percentage.

b. For **precision**, if all the balls all land in the same area write yes for precise, if two balls land in the same area, write somewhat and if the balls land in different areas, write no. *(see bulls eye illustration above)*

4. Allow 10 – 15 minutes for students to work together, discussing the provided materials and illustrating their plan in the space provided on the sheet. Some groups may finish faster than others.
5. Have students bring their illustrated design to the teacher before getting the materials needed to build their robot basketball player.
6. Give students about 15 - 20 minutes to build their model. Some groups may finish faster than others.
7. As students complete their model, have them raise their hands or bring the completed model to the teacher to perform the test in the testing zone.
8. If time and materials permit, allow students to make modifications and try again. If not, have students post their final score on the class chart and work on the Part D – evaluation phase on their student sheet.

Teachers, your role is a "guide on the side". As students present you with questions on how to do something you must resist the urge to tell them the "how". Respond with a general statement. For example: "You have been provided the task and materials you need to complete this task, work with your group in order to come up with a solution". If your students are not used to thinking on their own, you may have to reassure and encourage them to keep working…they can do it!

Closure:

Have a class discussion about what they noticed, or discuss the evaluation questions as a whole group. Some additional questions to ask:

a. What challenges did individual students or groups have with this activity?
b. What successes did individual students or groups have with this activity?
c. What would they do differently if they had more time?
d. After seeing other ideas, was there a design they didn't think about or would try?
e. Why is science important to us?

Assessment:

Have student's complete question #8 on the evaluation sheet on their own. Use either a post-it note or index card to collect their responses. Do they understand the "big picture" of how important science is to the real world?