Volleyball Machine Challenge

Instructions

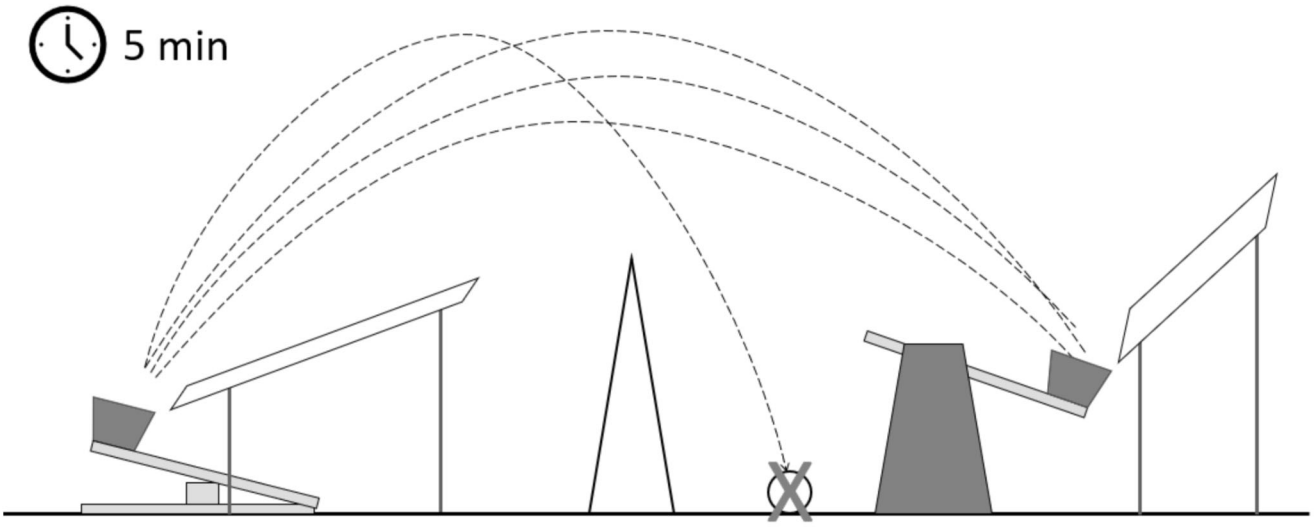
Name: _____

Date: _____

Overview: Your goal is to build two machines that can launch a ping pong ball back and forth over a net. The more times the ball goes over the net in five minutes (without touching the ground), the more points you score. You also score more points for using fewer materials to build your machines.

You can watch a video introducing the challenge here:
https://youtu.be/2awrEVrPpdI

This diagram shows some sketches of machines from the video. What other designs can you think of?



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Materials

You can use the following materials to build your launcher and receiver. Each item has a maximum allowable quantity and a point cost that will be deducted from your score.

Item	Maximum Quantity	Point cost (each)
Corrugated cardboard (max size 12"x12" or 30x30 cm)	2	10
Large paper or plastic cups (16–18 oz, or about 450–500 mL)	10	5
Paper (printer/copier paper, not construction paper or card-stock; letter or A4 size)	20	1
Wooden pencils (circular or hexagonal cross-section, approx. 7–8" or 18–20 cm length)	20	1
Wooden craft sticks (4.5" or 11.5cm)	20	1
Rubber bands (size 32, 3" long unstretched and 1/8" wide)	10	2
Roll of clear adhesive tape (Scotch® tape or equivalent, 1/2" or 3/4" width, max length 500")	1	10

Scoring

Calculate your score using this equation:

$$Total\ Score = \frac{100 \times (\#\ of\ times\ ball\ went\ over\ net)}{total\ materials\ cost}$$

where:

- "# of times ball went over net" is the number of times the ball went over the net before hitting the ground or getting stuck, or 5 minutes went by, whichever came first.
- The total materials cost is the sum of the point costs for all the materials used in your final design, as shown in the table above.

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Name: _____

Rules

Follow these rules when building and testing your volleyball machine:

Building

1. Only use items listed in the Materials section.
2. Build two machines (one for each side of the net). The machines can be different from each other.
3. Either machine can be "active" (meaning it launches the ball) or "passive" (meaning it lets the ball roll back over the net, powered by gravity).
4. Both machines must be freestanding. They cannot be taped to the ground or supported by a person.
5. Your machines cannot touch each other or the net. The two machines have to be separated by the width of the net.

Testing

6. One person at a time can use both hands to operate a machine to launch the ball (two people total, one for each machine).
7. After the ball is launched, nobody can touch either machine until the ball has stopped moving completely.
8. The ball is allowed to touch the net.
9. After the ball has come to a complete stop, you cannot touch or move the ball, even if you do not touch it directly. You can use both hands to operate the machine to launch the ball back across the net.
10. The ball cannot touch the ground. It is allowed to touch another material (like a piece of paper or cardboard) that is sitting on the ground.
11. You continue launching the ball back and forth over the net until one of three things happens:
    a. The ball touches the ground.
    b. The ball gets "stuck" and you cannot relaunch it without touching or moving it first.
    c. Five minutes pass.
12. If you need to make repairs, you must start over counting the number of launches at zero.
13. You can do as many tests as you want to try and get a higher score, but you can only submit one high score per team.

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Student worksheet

Directions: Use this worksheet to document your ideas and progress as you work on the volleyball machine challenge.

1. **Design**. Use this space to draw design ideas for your machines.

2. **Build**. Compare designs with your teammates and agree on what you will build. You can build one person's designs or combine multiple designs into new designs. Remember that you need one machine for each side, but they do not have to be the same.

3. **Test**. Test your volleyball machines, following the rules on page 3. Do the machines work like you expected? Did anything break? If so, what broke? How many times can you launch the ball over the net before it hits the ground or gets stuck? Write down your observations (answers to these questions and other things you notice) here.

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Student worksheet

4. **Iterate**. Your machines probably did not work perfectly on the first try. That is OK! You might need to cycle through steps 1–3 several times. What changes can you make to your designs to improve them? What happens when you modify your machines and test them again? Write down three observations and/or changes you made here (draw new sketches if necessary).

5. **Final Design.** What is working well about your final design? What could be improved if you had more time?

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Student worksheet

6. **Calculate your score.**

   a. How many times did the ball go over the net before it hit the ground, got stuck, or you reached the time limit?

   _____

   b. Use this table to calculate your total materials points. Even if you only used part of an item (like half a piece of paper, or part of a roll of tape), you still have to count all the points for that item. Fill in the "number you used" column and then multiply by the "Points (each)" column to calculate the subtotal for each material.

Item	**Points (each)**	**× number you used**	**= points subtotal**
Cardboard sheets	10		
Large paper or plastic cups	5		
Piece of paper	1		
Wooden pencils	1		
Wooden craft sticks	1		
Rubber bands	2		
Roll of tape	10		
		Total materials cost:	

   c. Calculate your total score using this equation.

$$\frac{100 \times (\#\ of\ times\ ball\ went\ over\ net)}{total\ materials\ cost} = \frac{(100 \times _____)}{_____} =$$

Total Score