

# Performance Task:

## Free Throw Adjustments

### Grade Level: 10 - 11

Referencing Vermont Proficiency-Based Graduation Requirements for Clear and Effective Communication and Mathematics

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## Overview

In this task, you will show your understanding of the rich process of modeling to **give advice to a person on how to calculate the best release angle for a free throw shot.**

The presentation of your process and reasoning during the development of the model, using diverse sources and classroom discussion for support, will display your knowledge of clear and effective communication.

## Standards and Learning Targets

*The following content standards, transferable skills and connected learning targets will be demonstrated and assessed in the culminating task:*

### TRANSFERABLE SKILLS

#### Graduation Proficiency: Clear & Effective Communication

- a. Demonstrate organized and purposeful communication.
- b. Use evidence and logic appropriately in communication.
- c. Integrate information gathered from active speaking and listening.
- d. Adjust communication based on the audience, context, and purpose.
- e. Demonstrate effective, expressive, and receptive communication, including oral, written, multi-media, and performance.
- f. Use technology to further enhance and disseminate communication.
- g. Collaborate effectively and respectfully.

### MATHEMATICS

#### 1. Modeling

- a. Use numerical phenomena or quantities to model a situation. (HSN.Q)
- b. Use equations, inequalities and functions to model and interpret situations. (HSA.SSE, CED, REI.D; HSF.IF.B,C, BF.A, LE, TF.B)
- c. Compare mathematical models for a situation.
- d. Interpret the results of applying the model in the context of the situation.

## Big Ideas/Enduring Understanding

The central idea is that complex situations can be modeled with mathematics to make reasonable conclusions about how the world works. Mathematicians use given information strategically within their skill set to determine the best model for the situation. Any model is imperfect. Mathematicians must be able to realize this imperfection, discuss how the model is limited, and acknowledge the model's importance in clarifying other aspects of the situation.

## Focus Questions

*What are the overarching and guiding questions students will answer in order to develop these enduring understandings?*

- How can I use mathematics to model this situation?
- Can I justify my methods?
- How accurate does my solution need to be?
- What are the limitations of my model?

## Culminating Task

The student will create a presentation that:

- Presents a model that elicits an answer to the prompt;
- Describes the process of problem-solving;
- References the classroom activities and discussions that preceded the task and how they impacted the process;
- References other sources and how they impacted the process;
- Justifies the findings; and
- Uses technology as appropriate to enhance the communication of his/her findings.

## Content/Sources/Materials

### Equipment Needed

Computers, camera, and graphing calculator

## Formative Tasks, Directions and Instructional Supports

Welcome.

Math is beautiful.

It is also messy. Rarely is the solution to any complex problem one easy integer. It is rational, irrational, non-existent, or often exists as a whole range of numbers.

Most citizen mathematicians are employed in a field other than pure math research. There is math application by people in all walks of life, where problem solving happens through using the tools with which each practitioner is comfortable and fluent. It can be a messy and exhausting and exciting process of discovery.

Nobody knows the answer or the best method by which to find it; this is why the problem needs to be solved.

We hope to represent this state of discovery and cyclical review within this performance task. **There will be no answer guide, as there is no one right answer.** We are looking for students to use their math skills creatively and justify their process effectively. We are looking for students to communicate their math claims with structured support. This process should reflect the authentic way math is used in the world. There is not one easy integer solution.

Enter the realm of modeling. We take the information we are given, we analyze which information needs focus, we make assumptions, and we make the best mathematical model we can with our resources. We discuss the features of the model and fully acknowledge the flaws. Ultimately, we use mathematics to make sense of a situation in which we do not know the answer and need to find out more about the world. We do the best we can. The person sitting next to us may have used a vastly different model, and arrived at a different answer. The more skills we have, the more likely our model will represent the situation as accurately as possible. Strong and worthy math can be used to justify many answers.

Knowing that many answers are possible, we believe it is worth the risk. We hope to inspire students to find the elegance of a well-designed model and the beauty of the numbers it brings (whether rational, irrational, existent or non-existent).

## Summative Assessment: Free Throw Adjustments

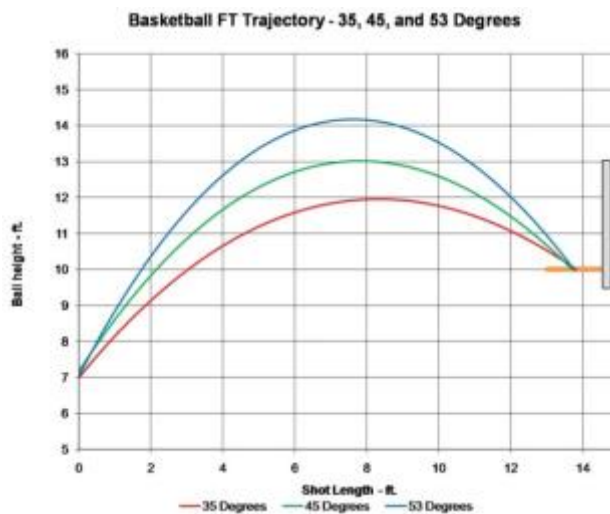
A basketball player on your high school team is working on free-throw shots. The research shows that a shot that enters the basket at an angle of 45 degrees is optimal. With a high arc, there is a loss of control. With a flat arc, the metal hoop impacts the potential for a basket. After reading [“In basketball, shooting angle has a big effect on the chances of scoring”](#) from The Washington Post, you decide that *angles of release* will be different depending on the player’s height, but should result in a 45 degree *angle of entry* regardless.

**Your task is to give advice to the basketball player to improve his/her free-throw shots.**

- Your advice should refer to data collected on and analysis of the player’s current free throws.
- Your advice should refer to how the player should adjust his/her angle of release and the maximum height of the ball on its path to the hoop to result in a 45 degree entry angle.
- While the path of the shot overall assumes the shape of a parabola, you should explain how you will use a parabola to find release and entry angles.

**Create a presentation that:**

- Addresses the player as your audience;
- Describes your process of solving this problem;
- References the classroom activities and discussions that preceded the task and how they impacted your process;
- References other sources and how they impacted your process;
- Presents your mathematical model of the player’s free throw shot;
- Mathematically justifies your advice; and
- Uses technology to enhance the communication of your findings.



[Learn more about Building the Perfect Arc.](#)

## Instructional Activity: Mathematical Communication

### Learning Targets

#### Graduation Proficiency: Clear & Effective Communication

- a. Demonstrate organized and purposeful communication.
- b. Use evidence and logic appropriately in communication.
- c. Integrate information gathered from active speaking and listening.
- d. Adjust communication based on the audience, context, and purpose.
- e. Demonstrate effective, expressive, and receptive communication, including oral, written, multi-media, and performance.
- f. Use technology to further enhance and disseminate communication.
- g. Collaborate effectively and respectfully.

### Texts/Other Materials Needed

- [Suggested example](#)
- Copy of Scoring [Criteria for Clear and Effective Communication](#)

**Estimated Duration of Task:** Approximately 45–60 minutes.

### Teacher Instructions

1. Choose an example of mathematical communication that will enable students to examine what makes it an effective example of clear and effective communication.
2. Share example with students.
3. As whole class or in small groups, ask students to discuss the aspects of the example according to the scoring criteria. Ask students to reflect on:
  - Where is it strong?
  - How might it be improved?

## Instructional Activity: Communicating Solutions

### Learning Targets

#### Graduation Proficiency: Clear & Effective Communication

- a. Demonstrate organized and purposeful communication.
- c. Integrate information gathered from active speaking and listening.
- d. Adjust communication based on the audience, context, and purpose.
- g. Collaborate effectively and respectfully.

### Texts/Other Materials Needed

- [Toothpick Activity](#)
- [http://mathpractices.edc.org/browse-by-mps?field\\_msp%5B%5D=7#results](http://mathpractices.edc.org/browse-by-mps?field_msp%5B%5D=7#results) (Pat, this link is not working.)

**Estimated Duration of Task:** Approximately 45–60 minutes.

### Teacher Instructions

1. Choose an activity that enables students to work with a partner to solve a problem or puzzle.
2. In partnerships or individually, students to grapple with the problem or puzzle.
3. Students communicate to another partnership or whole class how they approached solving problem or puzzle.

### Suggested Guiding Questions

- What were you thinking as you solved the puzzle?
- Did this process change as you solved additional puzzles? If so, how?
- How did the thinking and strategies of other people influence your decisions?
- What is a logical and efficient progression of steps you would suggest if you were helping someone else to solve one of the puzzles? Be ready to defend your reasoning.



## Instructional Activity: Class Discussion – NBA Free Throw Shooting

### Learning Targets

#### Graduation Proficiency: Clear & Effective Communication

- g. Collaborate effectively and respectfully.

### 1. Modeling

- a. Use numerical phenomena or quantities to a model a situation. (HSN.Q)
- b. Use equations, inequalities and functions to model and interpret situations. (HSA.SSE, CED, REI.D; HSF.IF.B,C, BF.A, LE, TF.B)
- c. Compare mathematical models for a situation.
- d. Interpret the results of applying the model in the context of the situation.

**Estimated Duration of Task:** Approximately 60 minutes.

Read and discuss the mathematics within [Nothing But Net: The Physics of Basketball Free Throws](#).

### Think/Pair/Share – Class Discussion

#### Suggested Guiding Questions:

- What are the big ideas of this article?
- The path of the basketball after release is a parabola. Why?
- Using the measurements in the article, draw a scale map of the path of the basketball from release to the basket. Why would it be important to label all distances accurately?
- How would changing any of the measurements affect the optimal path of the basketball?

## Instructional Activity: Three Acts Class Discussion – Will it Hit the Hoop?

### Learning Targets

#### Graduation Proficiency: Clear & Effective Communication

- a. Demonstrate organized and purposeful communication.
- b. Use evidence and logic appropriately in communication.
- c. Integrate information gathered from active speaking and listening.
- d. Adjust communication based on the audience, context, and purpose.
- e. Demonstrate effective, expressive, and receptive communication, including oral, written, multi-media, and performance.
- f. Use technology to further enhance and disseminate communication.
- g. Collaborate effectively and respectfully.

**Estimated Duration of Task:** Approximately 60 minutes

### Teacher Instructions

1. Students work collaboratively in small groups.
2. Groups review the three photos to analyze the amount of information needed to have a supported claim. Will he make the basket?
3. Groups watch Take 1 from website and begin the Three Acts activity (guidance below).
4. Groups use their resources to determine their claim, and mathematically support it.
5. Groups watch the end of video to find see the answer.
6. Class discussion of Three Acts, process and group collaboration (suggested guiding questions below).

### Suggested Guiding Questions for Classroom Discussion

- What is the least amount of information I can have to make an accurate judgment of his success?
- How can I find an equation for the quadratic equation with this information?
- Can I use symmetry in this situation? How?
- Can I use algebra in this situation? How?
- Can I use various tools to help me find an equation? How?
- What other real-world situations can be modeled with quadratic equations?
- How would you self-assess your role in the group collaboration?

### Texts/Other Materials Needed

[Computers to access Dan Meyer’s Activity](#): (Take 1)

[Guidance on Three Acts](#) (from National Council of Supervisors of Mathematics):

[Learn more about guidance on Three Acts](#)

## Rubric for Classroom Discussion

Performance Indicators	Beginning	Developing	Proficient	Expanding
<p>G. Collaborative effectively and respectfully.</p>	<p>I can</p> <ul style="list-style-type: none"> <li>Identify the features of effective collaboration.</li> </ul>	<p>I can</p> <ul style="list-style-type: none"> <li>Contribute my own ideas to group interaction.</li> </ul>	<p>I can</p> <ul style="list-style-type: none"> <li>Respond respectfully and thoughtfully to diverse perspectives to promote an exchange of ideas with reasoning and evidence.</li> </ul>	<p>I can</p> <ul style="list-style-type: none"> <li>Facilitate small and large group interactions or help others facilitate;</li> </ul> <p>Or</p> <ul style="list-style-type: none"> <li>Create alternative evidence that expands upon proficient.</li> </ul>
<p><b>Evidence:</b></p>				

## Instructional Activity: Praise, Question, Polish

### Learning Targets

#### Graduation Proficiency: Clear & Effective Communication

- a. Demonstrate organized and purposeful communication.
- b. Use evidence and logic appropriately in communication.
- c. Integrate information gathered from active speaking and listening.
- d. Adjust communication based on the audience, context, and purpose.
- e. Demonstrate effective, expressive, and receptive communication, including oral, written, multi-media, and performance.
- f. Use technology to further enhance and disseminate communication.
- g. Collaborate effectively and respectfully.

**Estimated Duration of Task:** Approximately 30–45 minutes

### Teacher Instructions

1. Partner students so they can share some data they have collected so far.
2. Introduce protocol for sharing work.
3. This activity can also be used once students have created their presentations.

### Partner Protocol: Praise, Question and Polish

1. Each partner shares his/her work and uses the following protocol to guide discussion.

#### Praise

- Partner shares or highlights something his/her partner did well.

#### Question

- What problem are you trying to solve?
- What strategies have you used to tackle the problem?
- What are the different tools that you have used to look at the problem?
- How did you build on the thinking and strategies of other people?
- How was your approach different than other people?
- What are some challenges you are trying to figure out?

#### Polishes:

- What revisions might you need to make?