Geometry

rich tasks mathematics

Instructional mathematics tasks are accessible to all learners because they invite students to wrestle with a problem. Students share their ideas, ask questions of one another, use and apply multiple representations, and collaborate to develop various solution pathways. Then, teachers use students' solutions to make the math visible, connect prior learning, and forecast new mathematical learning.

**Directions:** Launch the tasks in a whole group to provide opportunities for students to discuss their understanding of the task and suggest strategies to solve. Organize the students in pairs or groups of four to encourage participation. Provide manipulatives, chart paper, and markers.

## 1

**Topic**

Prove the perpendicular bisector theorem and its converse.

**Task**

Two lifeguard stands, 250 meters apart from each other on a beach, monitor separate zones within the water. The stands are set 30 meters back from the shoreline at an average tide. If you are to assume that the guard chairs are set 250 meters apart because that is the maximum distance a lifeguard can be expected to safely maintain, where might you swim in the ocean so that you can be equally seen or rescued by either lifeguard?

**Facilitate**

Allow students to use patty paper, graph paper, compasses, manipulatives, string, or any other items necessary to help them make spatial sense of the problem. Consider allowing groups to stand and demonstrate to help students visualize the scenario. Encourage groups to diagram their answer in some way, paying close attention to reasonability as they determine a range of distances.

**Make the Math Visible**

Select groups to present their solutions and sequence them in an order that helps students build a conceptual understanding of the perpendicular bisector and its relationship to isosceles triangles.

**Notes**

## 2

**Topic** Apply geometric methods to solve design problems in three dimensions.

**Task** Rain barrels allow people to collect and use rain water for tasks such as watering their lawns or washing their cars, which helps to save the water piped into their homes for drinking and/or cooking. This can be helpful in countries without adequate access to fresh drinking water. Design a rain barrel that will fit into the smallest space possible but will hold 150 to 250 gallons of rain, and calculate how much wood or plastic you will need to build each barrel.

**Facilitate** Discuss daily water usage with students to build an understanding of the context of the problem. Consider having students track their usage throughout a day or connecting the task to World Water Day activities in other content areas. Allow groups to use measuring tools to assess reasonability and encourage them to use tape to mark space within the room in order to better visualize their design.

**Make the Math Visible** Have students create and present a diagram or three-dimensional model of their design. As a class, debate the pros and cons of each design, discussing the implications of surface area on material cost, the space efficiency, and the volume capacity for each barrel. Consider having the class vote on the design that they believe best solves the water problem.

## 3

**Topic** Solve real-world problems involving right triangles.

**Task** A standard escalator moves at a rate of about 1.5 feet per second. In a busy city metro station, a large escalator moves pedestrians from the train platform to the street level, which is a vertical distance of approximately 30 feet. To remain safe, the horizontal base of a typical escalator must be about 1.732 times its vertical rise. About how many commuters could the escalator in this station move each hour?

**Facilitate** Prompt students to model the scenario pictorially and to pay attention to reasonability when determining how many people can fit on a given escalator at once. Consider having students stand in a line or visiting a stairwell to help students develop spatial reasoning.

**Make the Math Visible** Discuss the variation in group solutions, comparing how students chose to design the height, width, and depth of the stairs on the escalator in order to safely and efficiently transport commuters. Select and sequence responses in such a way that highlights common misconceptions and values a variety of reasonable solutions.

## 4

**Topic** Use coordinates to solve problems involving circles.

**Task** A small ship of marine biologists in search of a large pod of whales is anchored 5 nautical miles north and 8 nautical miles east of a location where the pod was recently observed hunting. The ship has a detection system that can pick up large sea animals within a 3-nautical mile radius. If the whales are currently 7 miles due south of their former hunting location and traveling directly northeast, when will they be within the detection range of the researchers, if at all?

**Facilitate** Prompt students to use multiple representations to arrive at both approximate and precise answers. Consider the following extension: If the whales are traveling at a rate of 6 nautical miles per hour and it is currently noon, at what time must the ship still be in its current location to detect the whales' location?

**Make the Math Visible** Compare the precision of the graphical approximation to the answer calculated using technology and/or algebraic methods. Discuss how the movement of the ship, the variation of the pod's course, or the current might affect the problem.

## 5

**Topic** Identify and describe relationships between the parts of a circle.

**Task** At what times are the central angles created by the minute and hour hands on a clock less than 90 degrees?

**Facilitate** Provide groups with clocks with movable hands or clock faces inside sheet protectors with dry erase markers, as well as protractors. Discuss how time can be read on analog clocks with the class and consider having groups model a few times with their materials to ensure that all students are able to attempt the problem.

**Make the Math Visible** Select and sequence group responses in a way that highlights multiple strategies and allows students to build an understanding of central angles. Compare how groups used the marks on the clock to inform their work and discuss the connections to the number of times the clock is partitioned and the corresponding degrees of the central angle.

# Adapt-a-Mathematical TASK Tool

Do you have a task that is not quite right? Use this guide to adapt the task to meet your needs!

## How does the task meet your STUDENTS' needs?

ACCESS and EQUITY: Ensure that the task is "responsive to students' backgrounds, experiences, cultural perspectives, traditions, and knowledge" (NCTM, 2014, para. 1, https://www.nctm.org/uploadedFiles/Standards_and_Positions/Position_Statements/Access_and_Equity.pdf). Consider students' language readiness, including access to mathematical vocabulary.

- How can you differentiate the context of the task to support the students' backgrounds, experiences, and cultural needs?
- How can you group students to engage the students' socio-emotional and developmental needs?
- How can you "open up" the task to encourage access to the task for all learners?
- How can you connect the task to the mathematics the students have learned and students' interests?

Notes

## How do you PLAN for students to learn from the task?

MATHEMATICAL GOAL: The task should provide students opportunities to access new mathematical knowledge and to solidify, consolidate, or extend knowledge. Tasks can be changed to highlight multiple learning needs and content standards. Ensure that you strategically connect the learning goal to the task.

- What do your students know how to do right now?
- What do you expect your students to understand as a result of this task?
- What do you anticipate students will do? What changes might you make as a result of your anticipation?

FACILITATE: Task facilitation is critical to student success. Consider how you will organize students and **design** purposeful questions to help them discover and connect mathematics concepts and procedures.

- What **questions** are you going to ask? What tools will you provide? How will students be grouped?
- How and when will you provide opportunities for student **discourse**?

Notes

## How do you move learning FORWARD?

FORMATIVE ASSESSMENT: Collecting information about student understanding will help you adjust instruction as you conduct the task.

- How will you listen, observe, and identify students' strategies?
- How will you respond to students' understanding?
- How will you provide feedback to students?
- How will you provide opportunities for students to provide feedback to one another?
- How will you provide opportunities for students to persevere and productively struggle through problems?
- How will you make the mathematics visible for your students?

Notes


*Rich Mathematical Tasks, Adapt-a-Mathematical TASK Tool*, created by Beth McCord Kobett, Greta W. Richard, and Megan Gitterman.


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