

NCTM Activity Sheets for
**High
School**



NATIONAL COUNCIL OF
TEACHERS OF MATHEMATICS

www.nctm.org

High School Resources

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Seven Things I Never Learned in Methods Class

—Margaret R. Meyer

- 1. Do not think that students never notice what clothes you wear or when you last cut your hair.** They are quite observant about such things because these concerns are very important in their own lives. When building a professional wardrobe, do make the choice of comfort over fashion, especially when you are buying shoes.
- 2. Do not bore your friends with school stories unless they are teachers, too.** A story that is funny to a teacher is often not funny to those in other occupations. Do try to balance your life with friends who work outside of education.
- 3. Do not take your health for granted when working with children.** Keep a box of tissues on your desk, and insist that students use them. Ask students to bring in replacement boxes from home; they are usually happy to do so. Wash your hands frequently.
- 4. Do not think you will always be twenty-something.** Pay attention to saving for your retirement. Take advantage of tax-sheltered savings plans.
- 5. Do not take too long to recover from your undergraduate degree.** Start a graduate program as soon as possible. Doing so will pay off well in the long run.
- 6. Do not isolate yourself behind your closed door.** Find colleagues with whom you can talk, plan, share successes and failures, and continue to grow professionally.
- 7. Do not ever tell your students how old you are, especially when they ask you directly.** Instead, add at least thirty years to your age when answering because that age is how old they really think you are. Do think about retiring when your answer starts to sound believable.

Explain your answers in full sentences on a separate sheet of paper.



Merck & Co., maker of the painkiller Vioxx, announced that it would pay \$4.85 billion to settle 26,600 lawsuits filed by 47,000 plaintiffs, who claimed that the drug had harmed users. For the settlement to take effect, 85 percent of the plaintiffs would have to agree to drop their cases.

The company claimed that it had won 12 of its first 17 cases.... The jury award in its first lost case was \$253 million.... Vioxx was pulled from the market three years ago.

Source: "Merck to Pay 4.85 Billion Dollar Vioxx Settlement," Associated Press, November 9, 2007

1. Each lawsuit includes how many plaintiffs, on average?
2. For the settlement to take effect, how many plaintiffs would have to agree to drop their lawsuits?

Consider a scenario in which all plaintiffs agree to accept the settlement in exchange for dropping their lawsuits.

3. What is Merck's total payout?
4. How much would each plaintiff receive if the settlement were divided equally among the plaintiffs?

Consider a scenario in which 85 percent of the plaintiffs agree to accept the settlement in exchange for dropping their lawsuits and the remaining lawsuits proceed to trial. Assume that these cases are won at the rate at which plaintiffs won the first 17 cases, with the same jury award of \$253 million each.

5. What is Merck's total payout?
6. Assuming that the number of lawsuits is directly proportional to the number of plaintiffs, determine how Merck's total payout is distributed among plaintiffs.

Consider a scenario in which the settlement fails to take effect because less than the necessary 85 percent of plaintiffs agree to the settlement in exchange for dropping their lawsuits. All lawsuits then proceed to trial. Assume that cases are won at the rate at which plaintiffs won the first 17 cases, with the same jury award of \$253 million each.

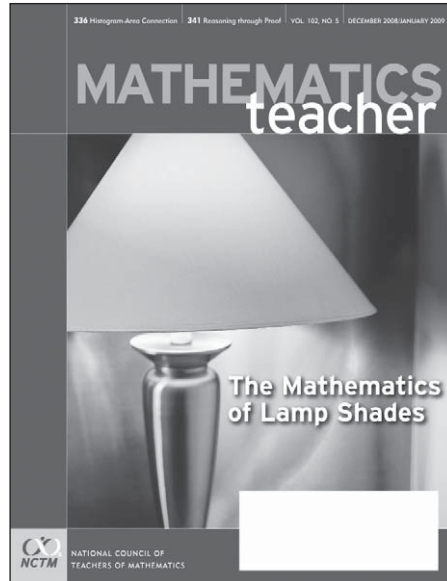
7. What is Merck's total payout?
8. Assuming that the number of lawsuits is directly proportional to the number of plaintiffs, determine how Merck's total payout is distributed among the plaintiffs.
9. Why might Merck have offered the settlement? Why might the plaintiffs choose to accept the settlement?

This activity sheet is from:

Deal or No Deal – For Real

This activity targets grades 6–8.

Content: Numbers and Operations, Connections/Applications,
Communications, Problem Solving



Journal: Mathematics Teacher

Issue: December 2008/January 2009

Department: Media Clips

It is available *for members only* at:

<http://www.nctm.org/publications/mt.aspx>

The aim of *Media Clips* is to provide opportunities to students to analyze items from the media, such as advertisements and newspaper articles, to answer mathematical questions related to the article. The section includes short items from the media that highlight interesting uses or misuses of mathematics that are appropriate for classroom study. *Media Clips* is a regular department of *Mathematics Teacher*.

MT is published nine times a year, monthly August through May, with a combined December/January issue.

These problems were selected from:

MT's Calendar Problems

This activity targets grades 9–12.

Source: www.nctm.org, Lessons and Resources pages

The purpose of the *Calendar Problems* is to provide teachers and students with a set of interesting and challenging problems that invite creative problem solving strategies. Teachers can use these problems as problem of the day or week, as warm-ups, as end of class challenges and/or brainteasers. *Calendar Problems* is a regular department of *Mathematics Teacher*.

The problem database is available *for members only* at:
https://my.nctm.org/ebusiness/members/calendar/default.aspx?journal_id=2

The problem database is sorted by topic. It includes thousands of problems featured in the *Calendar Problems* department of *Mathematics Teacher*. Only members have access to the problem archive.

Calendar Problems from *Mathematics Teacher*

Select Number of Problems

5 10 15 20 31

Select Topics

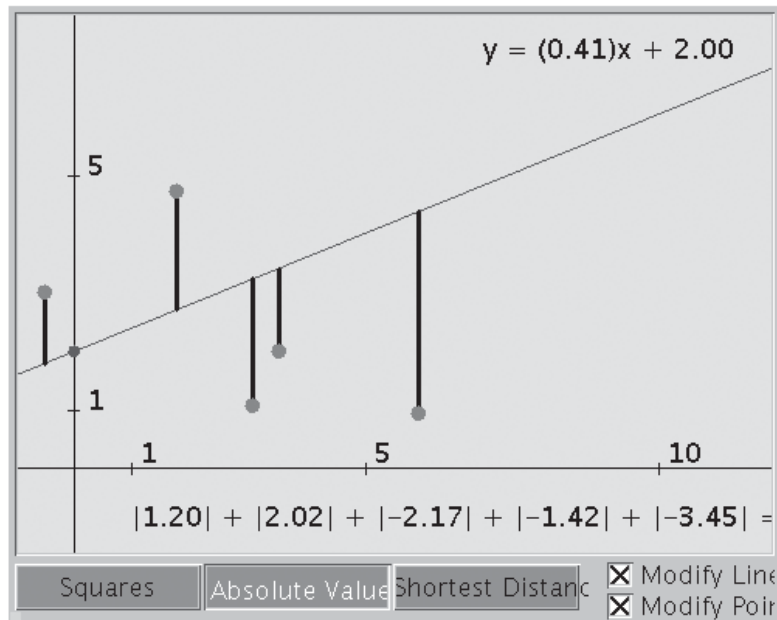
<input type="checkbox"/> Algebra (736)	<input type="checkbox"/> Number System (36)
<input type="checkbox"/> Calculus/Precalculus (77)	<input type="checkbox"/> Number Theory (312)
<input type="checkbox"/> Discrete Mathematics (106)	<input type="checkbox"/> Patterns (93)
<input type="checkbox"/> Combinatorics (104)	<input type="checkbox"/> Probability (197)
<input type="checkbox"/> Functions (33)	<input type="checkbox"/> Problem Solving/Reasoning (435)
<input type="checkbox"/> Geometry/Measurement (738)	<input type="checkbox"/> Statistics/Data Analysis (91)
<input type="checkbox"/> Spatial Sense (108)	<input type="checkbox"/> Technology (5)
<input type="checkbox"/> Modeling (53)	<input type="checkbox"/> Trigonometry (50)
<input type="checkbox"/> Number/Computation (805)	

Screenshot of High School Problem Database

Measuring Error in a Linear Model

NAME: _____

In this task a linear equation is used to model a set of data. By modifying the data points, explore how each of three methods—distance squared, absolute value, and shortest distance—measures how well the model approximates the data.



1. How do individual data points contribute to the error? How do these contributions differ among the three methods of measuring the “goodness of fit”?

2. How do the three methods compare when one of the points is far from the line and the rest of the points are quite close?

Explore measuring error in a linear model by manipulating data in the applet. Confirm your answers to the questions above. Explain in detail (include your sets of data points) on the back of this sheet a response to the following question.

3. For at least four different sets of data points, record the error measured by the absolute-value and shortest-distance methods. Be sure to use data sets that are quite different from one another in the number of points that are close to and far from the line. What relationships do you notice among the errors? (Hint: For each data set, try doing some arithmetic with the errors measured by the two methods.)

This activity sheet was modified from:

Understanding the Least-Squares Regression Line with a Visual Model: Measuring Error in a Linear Model

This activity targets grades 9–12.

Content: Data Analysis & Statistics, Line of Best Fit / Regression,
Data Representation

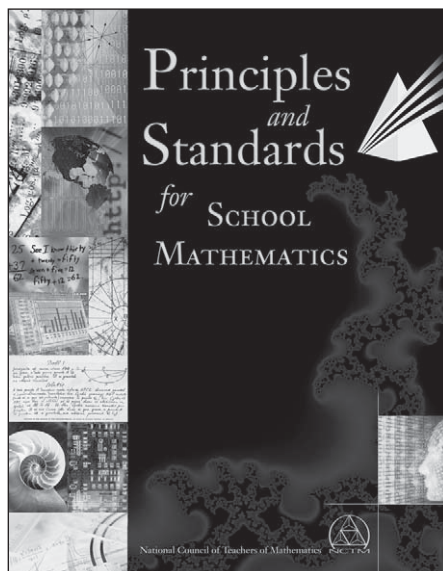
Have your students verify their solutions by using the applet found at
<http://standards.nctm.org/document/eexamples/chap7/7.4/index.htm>

Source: E-examples
NCTM Standards web site

It is available *free* at:

<http://standards.nctm.org/document/eexamples/>

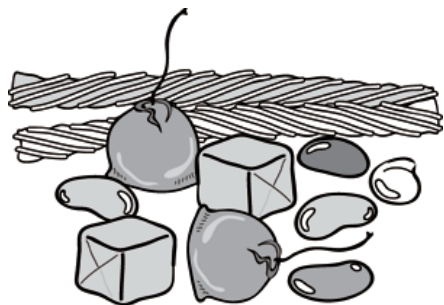
E-examples (Electronic Examples) are web-based interactive applets designed to provide students with the opportunity to gain experience with mathematical concepts. The Standards web site includes a collection of applets designed to accompany the *Principles and Standards for School Mathematics*.



The Candy Problem

NAME: _____

Read the following problem. Write down your thoughts for Questions 1 to 4, and discuss them with a partner. Then, solve the problem.



Daniel bought 1 pound of jelly beans and 2 pounds of chocolates for \$2.00. A week later, he bought 4 pounds of caramels and 1 pound of jelly beans, paying \$3.00. The next week, he bought 3 pounds of licorice, 1 pound of jelly beans, and 1 pound of caramels for \$1.50. How much would he have to pay on his next trip to the candy store if he bought 1 pound of each of the 4 kinds of candy?

1. What are the unknowns in the problem? How many are there? Assign a variable to represent each unknown.
2. Write equations based on the given information using the variables you chose. How many equations did you write?
3. What is the question asking you to find? Express this both in a sentence and in a mathematical equation.
4. What approach could you take to solving this problem? What are some of the obstacles you anticipate?
5. Solve the problem. Be prepared to share your solution and articulate the mathematics you used. There are multiple approaches to this problem but only one correct solution.

This activity sheet is from:

There Has To Be a System for This Sweet Problem

This activity targets grades 9–12.

Content: Algebra

In the lesson, students use problem-solving skills to find the solution to a multi-variable problem that is solved by manipulating linear equations. The problem has one solution, but there are multiple variations in how to reach that solution.

It is available *free* at:

<http://illuminations.nctm.org>



Illuminations is a Web site with over 600 resources, including lessons such as this one, interactive activities, and more. Content ranges from levels pre-K to 12, including topics in all of NCTM's standards: Number & Operations, Algebra, Geometry, Measurement, and Data Analysis & Probability. All resources on the Web site are **free** with new content added regularly. Check us out the next time you're looking for creative, innovative resources for your classroom!




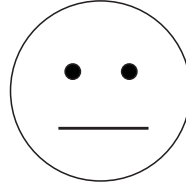







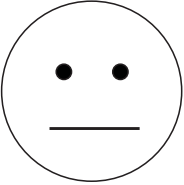
The Cost of a Smile

NAME: _____

The costs of combinations of frowns, smiles and neutral faces are shown.
How much is a smile worth?

Hint: Find a way to combine two of the rows or columns that have something in common.

Explain your reasoning in sentences on a separate sheet of paper.

	+		+		=	\$40
+		+		+		
	+		+		=	\$32
+		+		+		
	+		+		=	\$35
+		+		+		
	+		+		=	\$37
<u> </u>		<u> </u>		<u> </u>		
\$52		\$50		\$42		Sum

This activity sheet was modified from:

Figure This! Math Challenges for Families

This activity targets middle grades students.
Content: Algebra & Algebraic Reasoning, Systems of Equations



Source: Figure This!

It is available *free* at:
<http://figurethis.nctm.org>

Figure This! demonstrates challenging mathematics problems and emphasizes the importance of high-quality math education for all students.

Figure This! Mathematical challenges for families provide interesting math challenges that middle-school students can do at home with their families.

There are 80 different challenges. Each challenge features:

- a description of the important math involved
- a note on where the math is used in the real world
- a hint to get started
- complete solutions
- a “Try This” section
- additional related problems with answers
- questions to think about
- fun facts related to the math
- resources for further exploration.

Same Birth Month? No Way!

NAME: _____

Work through the problems in order. Show all mathematical steps in your solution. In addition, write a sentence explaining your reasoning.

1. If there were only two people in a room, what is the probability they were born in different months?

2. What if there were three people in the room?

3. What if there were six people in the room?

4. What if there were n people in the room?

This activity sheet was modified from:

Figure This! Math Challenges for Families

This activity targets middle grades students.
Content: Probability, Permutations / Combinations / Counting,
Experimental / Theoretical, Problem Solving



Source: Figure This!

It is available *free* at:
<http://figurethis.nctm.org>

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- questions to think about
- fun facts related to the math
- resources for further exploration.

Top Ten Things I Wish I Had Known When I Started Teaching

—Cynthia Thomas

10. Not every student will be interested every minute. No matter how much experience you have or how great you are at teaching, you will encounter times in the classroom when no student is interested! The solution is to change your tone of voice, move around the room, or switch from lecturing to some other activity. Maybe you can even use a manipulative to increase the students' understanding and, possibly, their level of interest.

9. If a lesson is going badly, stop. Even if you have planned a lesson and have a clear goal in mind, if your approach is not working—for whatever reason—stop! Regroup and start over with a different approach, or abandon your planned lesson entirely and go on to something else. At the end of the day, be honest with yourself as you examine what went wrong and make plans for the next day.

8. Teaching will get easier. Maybe not tomorrow or even next week, but at some point in the year, your job will get easier! Try to remember your first day in the classroom. Were you nervous? Of course; all of us were. See how much better you are as a teacher already? By next year, you will be able to look back on today and be amazed at how much you have learned and how much easier so many aspects of teaching are!

7. You do not have to volunteer for everything. Do not feel that you always have to say yes each time you are asked to participate. Know your limits. Practice saying, "Thank you for thinking of me, but I do not have the time to do a good job with another task right now." Of course, you must accept your responsibility as a professional and do your fair share, but remember to be realistic about your limits.

6. Not every student or parent will love you. And you will not love every one of them, either! Those feelings are perfectly acceptable. We teachers are not hired to love students and their parents; our job is

to teach students and, at times, their parents as well. Students do not need a friend who is your age; they need a facilitator, a guide, a role model for learning.

5. You cannot be creative in every lesson. In your career, you will be creative, but for those subjects that do not inspire you, you can turn to other resources for help. Textbooks, teaching guides, and professional organizations, such as NCTM, are designed to support you in generating well-developed lessons for use in the classroom. When you do feel creative and come up with an effective and enjoyable lesson, be sure to share your ideas with other teachers, both veterans and newcomers to the profession.

4. No one can manage portfolios, projects, journals, creative writing, and student self-assessment all at the same time and stay sane! The task of assessing all these assignments is totally unreasonable to expect of yourself as a beginning teacher. If you want to incorporate these types of exercises into your teaching, pick one for this year and make it a priority in your classroom. Then, next year or even the year after that, when you are comfortable with the one extra assignment you picked, you can incorporate another innovation into your teaching.

3. Some days you will cry, but the good news is, some days you will laugh! Learn to laugh with your students and at yourself!

2. You will make mistakes. You cannot undo your mistakes, but berating yourself for them is counter-productive. If the mistake requires an apology, make it and move on. No one is keeping score.

1. This is the best job on earth! Stand up straight! Hold your head high! Look people in the eye and proudly announce, "I am a teacher!"

Demystifying Magic Squares

NAME: _____

The square on the right is called a *magic square*. Each small square contains a whole number that is different from all the others. Adding the numbers in any row, column, or diagonal of a magic square always gives the same sum. An $n \times n$ magic square often uses each of the numbers 1 to n^2 exactly once, as in the example of a 4×4 magic square on the right.

1	8	10	15
12	13	3	6
7	2	16	9
14	11	5	4

1. Verify that the 4×4 square shown is “magic” and find its “magic sum.”
2. Complete the 3×3 magic square on the right, using each of the numbers 1 through 9 once and only once. What is its magic sum?

	1	
		2

Answer the following questions as you proceed.

- a. Explain why 3 cannot occupy the center square. What positions are possible for the 3?
- b. Explain why 4 cannot occupy the center square. What positions are possible for the 4?
- c. Why can none of the numbers 6, 7, 8, or 9 occupy the center square?
- d. By a process of elimination, what number do you conclude must occupy the center square?



Demystifying Magic Squares (continued)

NAME: _____

3. a. Try to make a magic square with a magic sum of 15 from each square shown below. Existing entries must remain where they appear. If the positions of these entries make it impossible to create a magic square, explain why.

	1	

1		

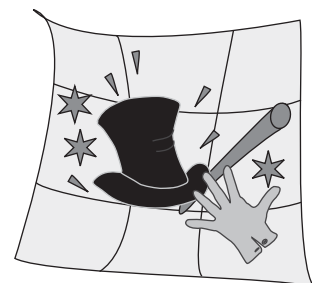
	1	

1		

	1	
2		

		1

- b. What patterns, similarities, or consistent features do you notice among the successful magic squares? List as many as you can.

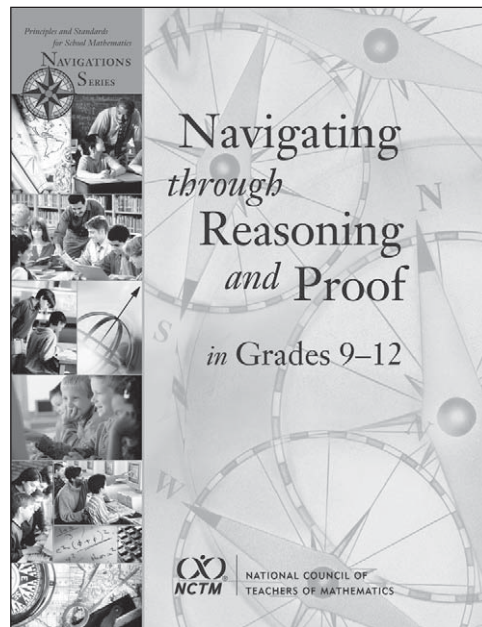


This activity sheet is from the book:

Navigating Through Reasoning and Proof in Grades 9–12

This activity targets grade 9–12.

Content: Algebra & Algebraic Reasoning, Problem Solving, Communication, Numbers and Operations, Number Theory



NCTM Stock Number: 13047

It is available *for sale* at:

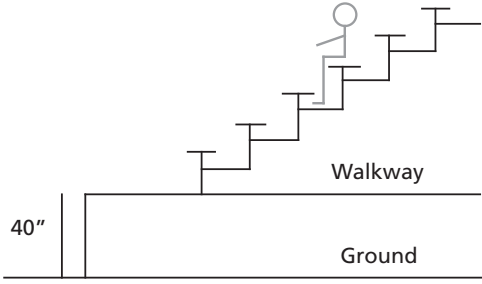
<http://my.nctm.org/eBusiness/ProductCatalog/product.aspx?ID=13047>

This book's activities highlight the important cycle of exploration, conjecture, and justification in all five mathematical strands. The students explore, becoming familiar with a mathematical domain. They recognize patterns and make conjectures. They justify, turning to logic to confirm—or deny—the generality of the patterns. They learn the value of a counterexample, explore the strengths and weaknesses of visual proofs, discover the power of algebraic representations, and learn that theoretical approaches can substantiate empirical results. In recognizing that looking back at assumptions can lead to new conjectures, they exhibit the fundamental habit of mind of the mathematician.

The Navigations Series translates Principles and Standards for School Mathematics into action. Each book includes practical, teacher-tested activities and a supplemental CD-ROM that features applets for students' use and resources for teachers' professional development.

How High?

NAME: _____



40"

Ground

Walkway

If you were sitting on a bleacher in the first row, how high above the ground would you be?

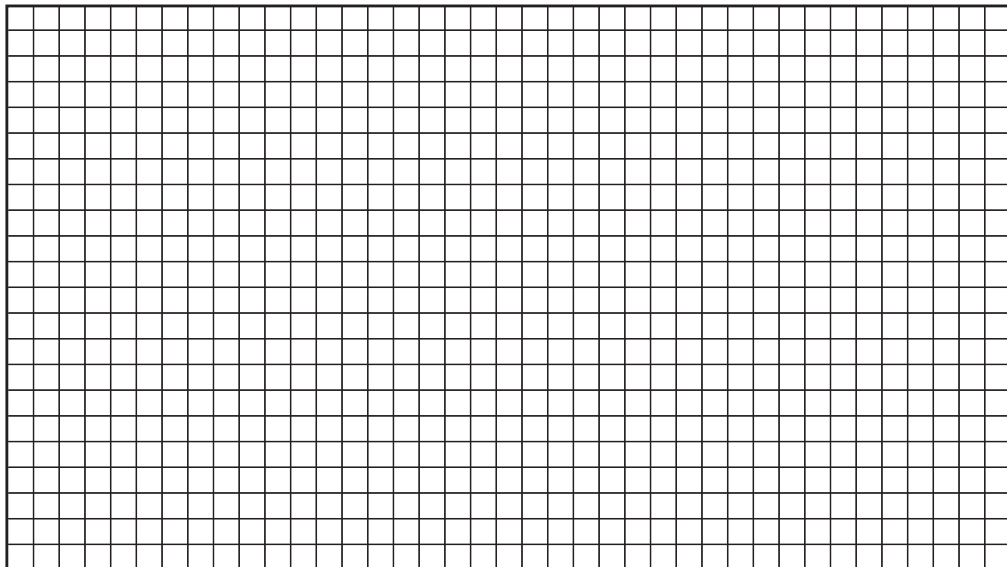
If you were sitting on a bleacher in the fifth row, how high above the ground would you be?

Can you find an equation that would allow you to determine how high a person is above the ground for any given bleacher row?

In a small group, decide what data you'll need to collect to answer the questions to the left. Next, go outside with your measuring stick to collect the data necessary to create the graph below.

Your goal is to ultimately find the equation that gives you your height above the track surface from any one of the sixteen bleachers. To do this, you will start by collecting 5 data points. The bleachers are numbered, and you will need to set up your table so you have a bleacher number and a corresponding height. Measuring sticks will be provided, and inches will be used as your vertical measurement. Round everything to the nearest whole inch.

Next, the data will be graphed.



Find an equation. _____

Make a general statement relating a bleacher and height.

This activity sheet is from the book:

Responding to Diversity: Grades 9–12

Content: Algebra & Algebraic Reasoning, Linear, Graphing,
Data Analysis and Statistics, Data Collection, Data Representation



NCTM Stock Number: 13410

It is available *for sale* at:

<http://my.nctm.org/eBusiness/ProductCatalog/product.aspx?ID=13410>

The instructional strategies presented in this volume reflect that diversity can come in various forms. Written by teachers who have experimented with different teaching techniques in the classroom, these articles are presented in three formats—cases of classroom practice, instructional strategies, and teacher development. The articles demonstrate how connecting real-life activities with mathematical concepts, and building on students' knowledge and experiences, can help them excel in the classroom. Strategies that can immediately be implemented to help students form better connections with the content they are studying are also described.

Assessment Samples

NAME: _____

1. What is the units digit of 3^{1992} ? Write a convincing mathematical argument that supports your solution.

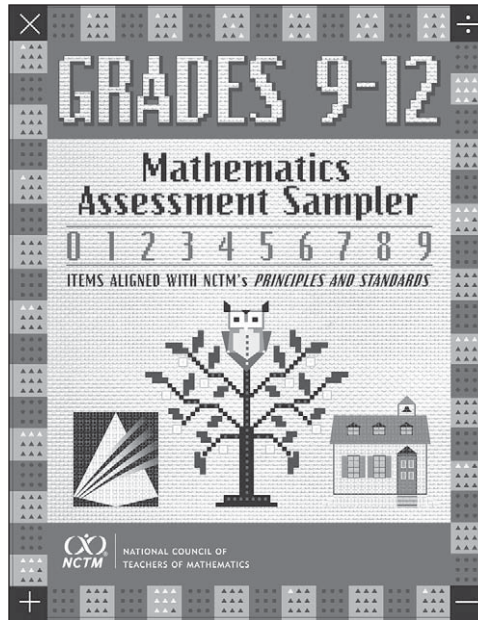
2. If a certain medicine is absorbed by your body at a rate so that $\frac{1}{3}$ of the original amount is left after 8 hours and if your doctor gives you 10 grams today and does not want more than 10 grams to accumulate in your system, how much medicine should she give you tomorrow at the same time?

This activity sheet was modified from:

Mathematics Assessment Sampler: Grades 9–12 **Items Aligned with NCTM's *Principles and Standards***

This activity targets grades 9–12.

Content: Numbers and Operations, Algebra & Algebraic Thinking,
Number Patterns, Functions & Relations



NCTM Stock Number: 12932

It is available *for sale* at:

<http://my.nctm.org/eBusiness/ProductCatalog/product.aspx?ID=12932>

The intent of the Assessment Sampler Grades 9–12 writing group is to supply teachers with sample assessment items that produce an accurate picture of their students' thinking, to guide teachers' instructional decisions, and to serve as models for creating original assessment items. The items in this sampler are selected or modified from state, national, and international assessments.

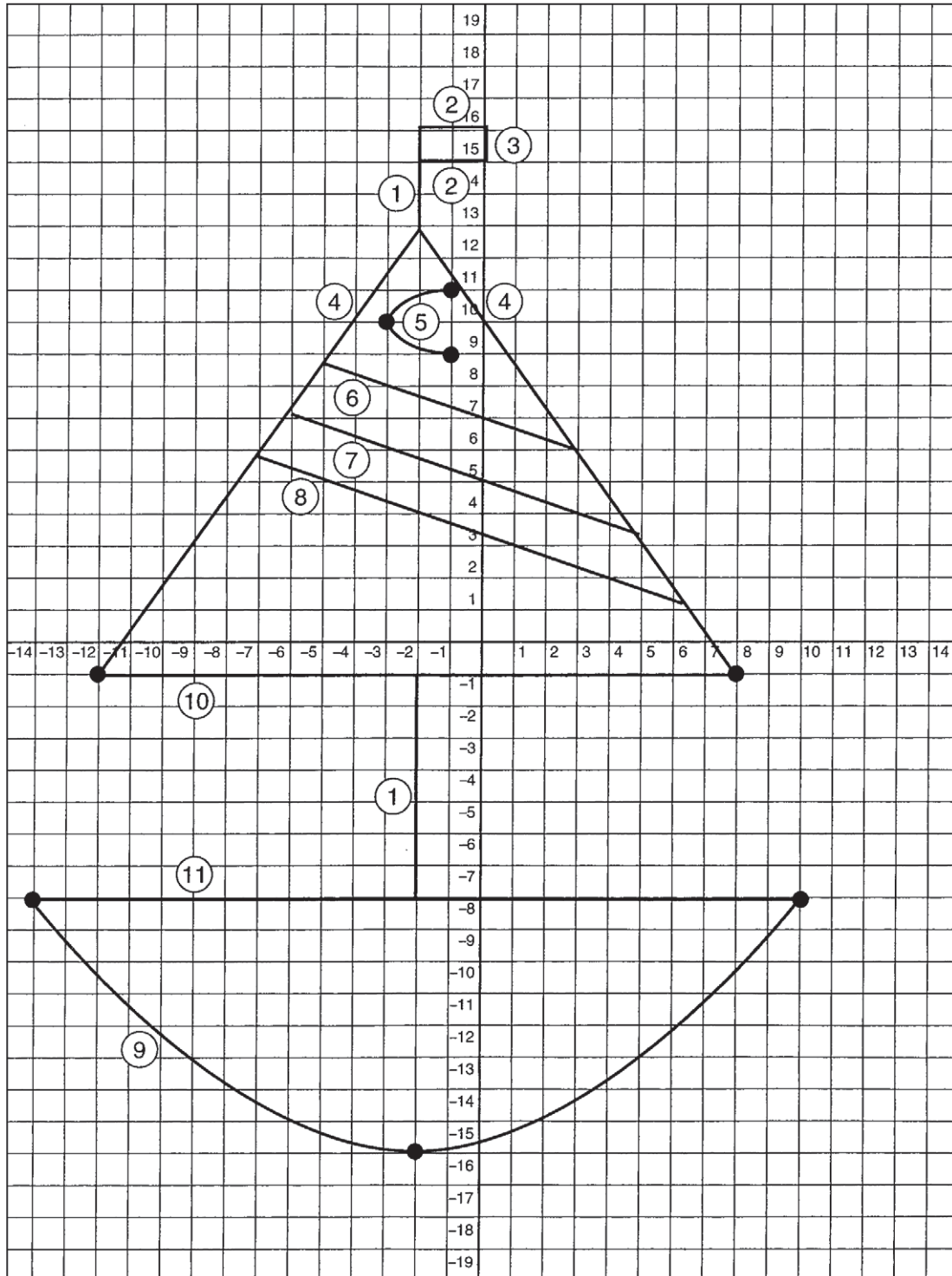
The types of items included are multiple choice, short response, and extended response. All items either require students to explain their answers or ask comparative questions among answer choices. Selected samples of student work either exemplify a correct response or typify certain categories of student errors.

Graphing a Sailboat

NAME: _____

Directions

1. Find at least one equation for each section of the graph from 1 through 11.
2. Use three different forms of equations for sections 6, 7, and 8.
3. Use domain or range restrictions and compound statements using “and” and “or” where appropriate.

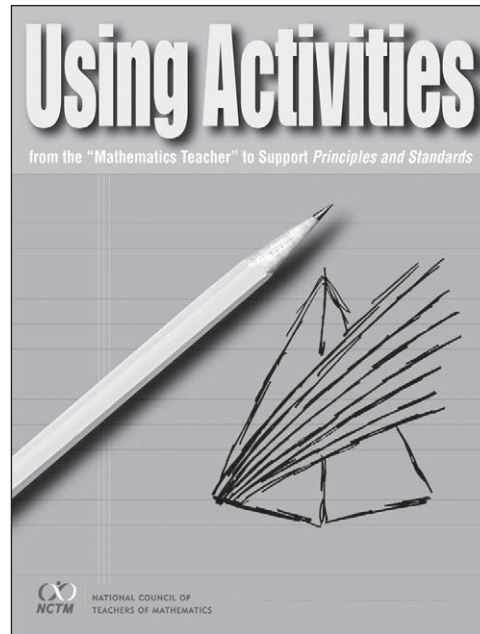


This activity sheet is from the book:

Using Activities from the “Mathematics Teacher” to Support *Principles and Standards*

This activity targets grades 9–12.

Content: Algebra & Algebraic Thinking, Graphing, Functions & Relations



NCTM Stock Number: 12746

It is available *for sale* at:

<http://my.nctm.org/eBusiness/ProductCatalog/product.aspx?ID=12746>

The “Activities” section of NCTM’s *Mathematics Teacher* journal gives a snapshot of what and how mathematics has been taught over the past thirty years. This particular selection of activities, whose topics range from slope and volume to nonperiodic tilings and the methods of voting, was chosen to help teachers as they reach toward the vision of mathematics teaching and learning as described in NCTM’s *Principles and Standards for School Mathematics*. The activities can be used to replace a lesson in a textbook, supplement a lesson, or introduce students to applications of mathematics not previously considered. Notes from the authors include objectives, materials needed, suggestions for using the activities, and sometimes extensions of the activity. Also featured is a grid to help teachers choose the activities that best meet the needs of their students.

Marvels of Multiplication

NAME: _____

Explain your answers in full sentences on a separate sheet of paper.

Marvelous Representations

Area models help us think about multiplication as representative of the area of rectangles. Once you understand this concept, you can use models similar to the area model, with factors that are represented as symbols or variables. Think about an unknown length represented by \blacklozenge . We can use a rectangle with a length of \blacklozenge and width of 6 to show an area of $6\blacklozenge$ as seen in the left part of the figure below. We can show the distributive property using a length of $\blacklozenge + 5$ and a width of 6 to show $6(\blacklozenge + 5) = 6\blacklozenge + 30$.



Because the partial products are unlike terms, they cannot be combined, and the sum is simply written as $6\blacklozenge + 30$.

- Sketch a rectangle that models the multiplication of $4(\odot + 7)$.

Marvels of FOIL

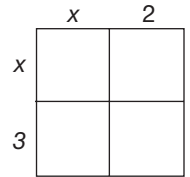
Every time you multiply a two-digit number by a two-digit number, you are using an extension of the distributive property.

Nissa
27
<u>x 15</u>
35
100
70
<u>+ 200</u>
405

- Look at Nissa's work when she multiplied $27 \cdot 15$. Explain how this is an example of the distributive property.

This model can also serve as a bridge to understanding the multiplication of polynomials (the sum or difference of many terms. A term is the product of variables and constants). When multiplying two polynomials, you can use partial products and then find the sum.

- Use the area model on the right to find the partial products of $(x + 3)(x + 2)$.



Notice that the product of $(x)(x)$ is x^2 and is actually a geometric square. That is why x^2 is read as "x squared." The four resulting products, $x^2 + 2x + 3x + 6$, can be simplified by combining like terms and writing $x^2 + 5x + 6$. Some mathematicians use the acronym **FOIL** to multiply two binomials such as the following: $(x + 3)$ and $(x + 2)$. Many mathematics students also use the FOIL acronym.

- **F** stands for the product of the **F**irst terms in each set of parentheses.
 - **O** stands for the product of the two **O**utside terms.
 - **I** stands for product of the **I**nside terms.
 - **L** stands for the product of the **L**ast terms in each set of parentheses.
- Look at your area model in number 2 and explain how FOIL relates to the partial products of question 1.

F
O
I
L

- Use FOIL to find the product of $(x + 8)(x + 12)$.

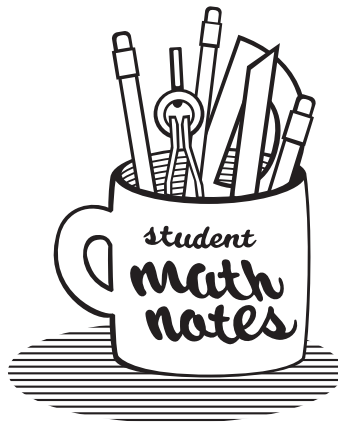
This activity sheet was modified from:

The Marvels of Multiplication

This activity targets grades 9–10.
Content: Numbers and Operations, Algorithms,
Multiplication & Division, Representation

Source: Student Math Notes

Issue: November 2008



Student Math Notes offers great resources for teachers and teacher educators at grades 5-10. Downloads are free to individual members of NCTM.

It is available *for members only* at:

http://my.nctm.org/eresources/journal_home.asp?journal_id=5

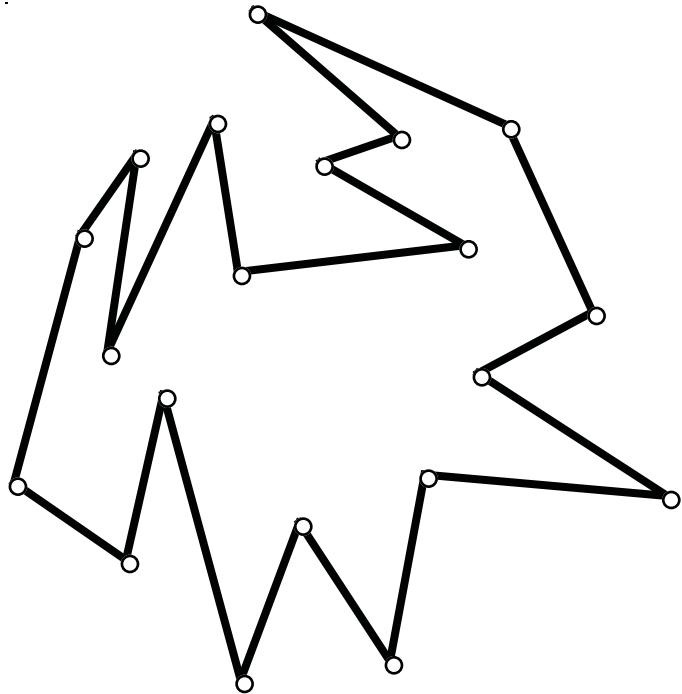
Art Gallery Problem

NAME: _____

Explain your answers in full sentences on a separate sheet of paper.

The 20-sided polygon shown below represents the floor plan of an art museum. Guards or sensors are to be placed at some of the vertices so that if a “point intruder” is detected in the interior of the polygon an alarm will sound. An interior point I is visible from a point P on the boundary, where P is not necessarily a vertex, if the line segment from P to I contains no points in the exterior of the polygon. A polygon with a set of locations for the sensors is said to be well-guarded if every point in its interior is visible from at least one sensor, and hence any intruder in the interior will be detected.

- What is the smallest number of sensors located at vertices needed for this particular polygon to be well-guarded?
- The number found in part (a) may not be sufficient for every 20-sided polygon. Experiment by drawing other 20-sided polygons. What is the largest number of sensors located at vertices that might be required for some 20-sided polygon to be well-guarded?



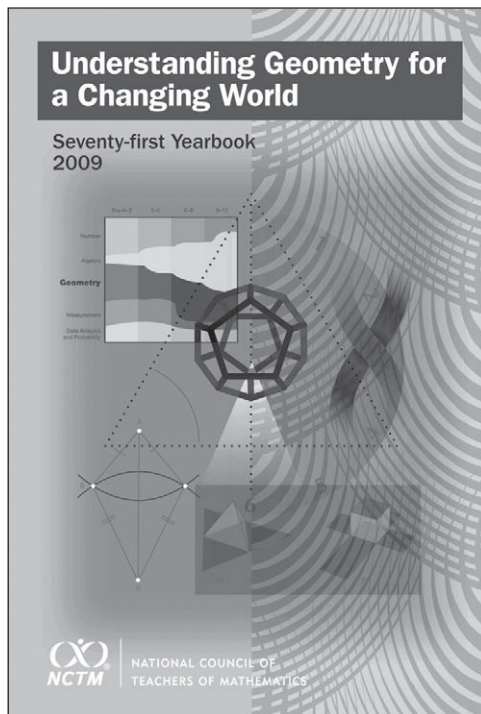
- Find a formula (depending on n) for how many guards (sensors) located at vertices of any n -sided polygon are needed to guarantee that an intruder into the interior of the polygon will be detected. Furthermore, provide a method for determining at which vertices of the “art gallery” the guards should be placed.



This activity sheet is from:

Understanding Geometry for a Changing World Seventy-first Yearbook

This activity targets grades 9–12.
Content: Geometry & Measurement, Problem Solving



NCTM Stock Number: 13466

It is available *for sale* at:

<http://my.nctm.org/eBusiness/ProductCatalog/product.aspx?ID=13466>

NCTM's *Principles and Standards for School Mathematics* (2000) asserts that geometry is the one content standard that should receive relatively constant attention from prekindergarten through grade 12. NCTM's seventy-first yearbook focuses on the developments made in the understanding of student's learning of geometry and the availability of new tools for teaching this important subject.

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