Learn Through Experience

ALGEBRA MYSTERY MAZE

Solving Algebra Chains within a Maze Competition

NATE CATTELL graduated from Pennsylvania State University with a BA in graphic design. He later earned his Pennsylvania Elementary Teaching Certification and has taught sixth grade in the State College Area School District for 31 years. In 1991, Nate was the Pennsylvania recipient of a Presidential Award for Excellence in Mathematics Teaching. He delights in creating new challenge activities for his students. For Interact Nate also authored CHALLENGE MATH PROJECTS (2000) and GEOMETRY CHALLENGE (2002).

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10200 Jefferson Blvd.
P.O. Box 802
Culver City, CA 90232-0802
(800) 359-0961 • www.teachinteract.com
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The nationwide movement for high standards has not only determined what students should learn, but also has mandated that students demonstrate what they know. ALGEBRA MYSTERY MAZE is a standards-based program addressing National Math Standards and provides many opportunities for performance assessments. Students apply their math skills and creativity to solve algebraic equations, algebra word problems, and mazes. The cooperation, peer teaching, and group decision-making address Applied Learning Standards.

National Standards for School Mathematics

Computation and Estimation Standard

- Using computing and estimating to solve problems

Algebra Standard

- Developing an initial conceptual understanding of different uses of variables
- Using symbolic algebra to represent situations and to solve problems
- Recognizing and generating equivalent forms of simple algebraic expressions

Measurement Standard

- Apply appropriate techniques, tools, and formulas to determine measurements
- Understand measurable attributes of objects and units, systems, and processes of measurement

Problem Solving

- Build new knowledge through problem solving
- Apply and adapt a variety of appropriate strategies to solve problems

Communication Standard

- Organize and consolidate their thinking through communication
- Communicate their math thinking coherently and clearly to peers, teachers, and others
- Analyze and evaluate the mathematical thinking and strategies of others
- Use the language of mathematics to express mathematical ideas precisely

California Applied Learning Standards

Standard 6. Students will understand how to apply communication skills and techniques. Students will demonstrate ability to communicate orally and in writing.

Standard 8. Students will understand the importance of teamwork. Students will work on teams to achieve project objectives.

STANDARDS

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Extensions

Most students need a lot of practice to solve algebra problems confidently. ALGEBRA MYSTERY MAZE offers a way for students to gain that confidence in the exciting setting of friendly competition. You may tailor the difficulty and length of the ALGEBRA MYSTERY MAZE experience to your individual classes. The Teacher Guide and Student Guides provide instruction and samples to teach necessary math skills. You may supplement the instruction provided as dictated by the needs of your students. You may also substitute your own choice of algebra problems for some or all of the competitions.

Every activity in ALGEBRA MYSTERY MAZE encourages students to use higher-level thinking skills. Knowledge, application, analysis, evaluation, and synthesis are all needed to work through the various phases of this experience. Through their work in ALGEBRA MYSTERY MAZE your students will understand and experience the following:

Knowledge

- Understand that letters represent numbers in equations
- Understand meaning and application of *order of operations*
- Understand meaning of *equation, variable, transformations, and reciprocals*

Skills

- Apply algebra skills to solve algebraic equations
- Apply algebra skills to solve algebra word problems
- Apply learned concepts to new problems
- Solve a problem in a variety of ways
- Work cooperatively with other students to develop problem-solving strategies
- Apply visualization, measurement, and estimation to construct a maze

Attitudes

- Enjoy increased confidence to solve algebraic equations quickly
- Enjoy increased confidence to develop different approaches to problem solving
- Appreciate the use of algebra to solve real-life word problems
- Appreciate the value of collaborative working relationships
- Demonstrate the willingness to take risks based on knowledge, estimation, math concepts, and visualization

PURPOSE

OVERVIEW

ALGEBRA MYSTERY MAZE is an exciting unit that causes students to develop and review algebra skills while they design and solve mazes. The mazes require teamwork and decision making as students use their previous experiences to help them shape new decisions. Effort, skill, wise decision-making, and a little luck are necessary to amass the most centimeter lengths by the end of the unit.

In teams of three, students apply their algebra skills to solve algebraic equations and simple algebra word problems. These problems form chains—sets of math tasks requiring that they use the answer from one problem to solve for a new unknown in the next problem. The points they earn in the Algebra Chain activities translate into centimeter (cm) lengths. The teams use the cms earned and apply other math skills (measurement and math communication) to navigate mystery mazes. Students work cooperatively as they rotate through the roles of Measurer, Designer, and Recorder. After completing all the chain activities and mazes, the members of each team compete by designing individual mazes to challenge their classmates. *Marble Maze Challenge* is the exciting culmination of the unit. Each team designs a 3-dimensional maze with baffles and turns within a covered box. They challenge others to roll a marble from a starting hole to an exit hole in the shortest possible time.

Differentiation Opportunities

ALGEBRA MYSTERY MAZE incorporates Howard Gardner's Multiple Intelligences:

- **Visual-spatial** — drawing and creating verbal/physical imagery
- **Bodily-Kinesthetic** — hands on experiences
- **Interpersonal** — interacting and planning with others
- **Intrapersonal** — reflecting on solutions, generating personal creative solutions
- **Linguistic** — using words effectively in communicating orally and when writing evaluations (reflections)
- **Logical-Mathematical** — reasoning, calculating, thinking conceptually, and abstractly, and seeing and exploring number relationships

Special Needs Students

Like all Interact units, ALGEBRA MYSTERY MAZE provides differentiated instruction through its various learning opportunities. Students learn and experience the knowledge, skills, and attitudes through all domains of language (reading, writing, speaking, and listening) and math (counting, tallying, computing, etc.). Adjust the level of difficulty to best fit the needs of your students. Allow students to use calculators. Assist special needs students in the activities to utilize their strengths and to succeed. Work together with the Resource Specialist teacher, Gifted and Talented teacher, or other specialist to coordinate instruction.

ALGEBRA MYSTERY MAZE makes extensive use of Algebra Chains to teach and reinforce algebra skills. An algebra chain is a competitive device that will enliven your regular class work and gather assessments at the same time. The idea is simple: your students compete in teams to solve algebra equations or algebra word problems.

1. **What is an Algebra Chain?**
   a. An Algebra Chain is a set of math tasks distributed simultaneously to all students.
   b. Student teams work as quickly as they can to complete each new problem correctly.
      - Students solve each equation independently, then consult team members to check their accuracy.
      - Any difference in results flags an error on the part of one team member.
   c. They use the correct answer from one problem as the value for the unknown in the next equation.
   d. Teams amass centimeter lengths (hereafter called cms) for the number of problems they solve correctly, and by the order they finish in the class (first, second, third, etc.)
      - Each Algebra Chain has a multiplier value for awarding cms for correct responses.
      - Cms earned indicate success in both solving Algebra Chain problems and using other math skills (measurement, computation, and math communication).

2. **How Does an Algebra Chain Work?**
   a. To begin, you will state the value of the first unknown and direct students to write it in the top box.

Sample from page 8 of the Student Guide.	
Value of first unknown	(z = 4)
1. [(z × 3) ÷ (4 ÷ 2)] = a	(a = 6)
2. (6 × 6) ÷ (15 − a) = b	(b = 4)
3. [(30 × 10) + b] ÷ 4 = c	(c = 76)
4. [(c + 4) ÷ (72 ÷ 9)] = d	(d = 10)

   b. Each Algebra Chain has a corresponding **Key** for your use. To verify that teams are generating correct answers, move around to all teams with **Key** in hand.
   c. Check only the Recorder's work. If you find a mistake, it is a team mistake. Indicate the last correct answer and give a hint for solving the problem (if necessary).

Review the teaching pages for each chain thoroughly to enable your students to solve the equations or problems.

Use the correct answer from one problem as the value for the unknown in the next equation.

All students on the team work the problems independently and check their accuracy with each other. Because students write answers in boxes, checking the papers while walking from team to team is easy.

TEACHING TIP

Just find the last correct boxed answer and circle the next box. Students will begin again by reworking the circled problem.

As with any activity, there will be teams that finish an Algebra Chain before the others. Be prepared to assign an activity to occupy teams that finish early. See ***Extensions*** *(page 10) and* ***Assessment*** *(page 11) for more information about such assignments.*

d. Circle only the ***first*** problem in a string of errors that is incorrect. Students must rework the incorrect problem and all following equations based on that answer.
e. Obviously it is essential that you keep moving from team to team while checking so that a team does not work a whole chain using an incorrect answer.
f. Encourage students to work as quickly and as accurately as they can. Teams that finish first or second have an advantage over teams that finish later.
g. Teams earn centimeter lengths (cms) for each problem they solve correctly, and additional cms depending on what order they finish in the class (first, second, third, etc.)
h. To determine the total cms earned, multiply the number of correct problems by the multiplier for that chain. (7 correct x multiplier n = 7n cms)

3. **Algebra Chains and Mazes**
Student teams spend the cms they earn during the Algebra Chain competitions to navigate mazes.
a. They select a starting point while studying only a partial maze, and navigate to any end mark on the complete maze.
b. Following strict navigation and measurement rules, they attempt to navigate the maze by using the least number of cms possible.

4. **Algebra Chains and Competition**
The competition in ALGEBRA MYSTERY MAZE is supposed to be friendly. The timed Algebra Chains are meant to add excitement to the routine of practice.
a. Depending on the skill level of your students, the competitions may become lopsided. No one wants to win a competition if the opponents are not worthy competitors.
b. Use the **Extensions** (teaching directions begin on page 51) to enable students to earn additional cms and level the playing field. This will sharpen team spirit and enhance team competition during the final maze competitions.
c. At the end, many students will recognize that luck plays a role in ALGEBRA MYSTERY MAZE.

1. **Before you Begin**
   Read this entire Teacher Guide and the Student Guide. Decide how you will use ALGEBRA MYSTERY MAZE in your math curriculum. Modify the procedures outlined for ALGEBRA MYSTERY MAZE to best fit your teaching preferences and your students' needs.
   a. Study the Algebra Chain activities.
   b. Familiarize yourself with the various mazes.
   c. Use the **Daily Directions** to lead your students through the steps for successful friendly competition through the Algebra Chains and mazes.
   d. Determine how you will stage the *Marble Maze Challenge*.
   e. Use **Extension** activities to supplement your regular curriculum or keep the competition more even.

2. **Using the Teacher Guide**
   Throughout the Teacher Guide Interact employs certain editorial conventions to identify materials.
   a. In preparing materials, *class set* means *one per student*.
   b. One *Day* on the **Unit Time Chart** is the length of a normal *class period*—45 minutes to one hour.
   c. All transparency masters and student handouts are listed by name using ALL CAPITAL LETTERS.
   d. Teacher reference pages are named in **Bold**.
   e. Special events are named using *Italics* (e.g., the *Individual Maze Competition*).
   f. In lieu of points students earn centimeter lengths (cms).

3. **Using the Student Guide**
   The Student Guide introduces students to ALGEBRA MYSTERY MAZE. It also includes teaching pages with examples. Use the Student Guide to teach individual concepts:
   - Order of operations (page 2)
   - Substitution of a numerical value for a variable (page 3)
   - Transformations involving addition and subtraction (page 4)
   - Transformations involving multiplication and division (page 5)
   - Using reciprocals to solve algebraic equations containing fractions and decimals (page 6)

SETUP DIRECTIONS

15 days

4. **Planning your Schedule**
   The daily lesson plans describe 15 days of lessons. This is only a recommendation.
   a. Adjust the timeline to accommodate your own teaching objectives and the needs and capabilities of your students.
   b. If your students are familiar with solving algebra equations, you can abbreviate these lessons.
   c. See **Adapting Algebra Mystery Maze** (page 15) for more information about the unit and alternative schedules.

If necessary, create a team of four and call the fourth person Member. This person will enter the rotation after Designer and before Recorder.

5. **Grouping Students**
   Arrange your class into heterogeneous groups of three students. Each day they work as a team; there are three roles: **Recorder**, **Measurer**, and **Designer**.
   a. Each role has a primary responsibility for the day, but all members of the team must help one another to get the jobs done successfully and on time. The roles rotate with every new Algebra Chain.
   b. Use the COOPERATIVE GROUP WORK RUBRIC as often as necessary to reinforce good behavior and to give concrete feedback to students who are not working cooperatively.

Remember that an important aspect of cooperative learning is to develop positive team dynamics and to promote self-confidence. Take some risks when deciding grouping, but create teams that will succeed with minimal behavioral issues.

6. **Preparing your Classroom**
   a. Create a bulletin board to display samples of mazes. Use the Internet to find pictures to download. See **Setup Directions #12**, **Using the Internet** (page 9) for more information.
   b. You may also designate an area on the bulletin board to record team cms.
   c. Students need a work area large enough to work Algebra Chain problems, hold discussions, and construct mazes. Three student desks arranged side by side is usually adequate. The **Recorder** always sits in the middle desk on Algebra Chain days. The **Measurer** always sits in the middle desk on Maze days.
   d. At the end of each day, insist that teams collect all their materials and store them safely in a designated area. If the materials are too bulky for the team folders, have students put all work in large paper bags marked with team names.
   e. Consider making a large poster of the COOPERATIVE GROUP WORK RUBRIC to hang at the front of the class.

7. **Teacher Reference Pages**
   This unit includes answer keys for all regular unit activities and **Extensions**.
   - **Pretest/Posttest Key**
   - **Algebra Chains 1–6 Keys**
   - **Individual Assessment Chains 1–6 Keys**
   - **Additional Problems Maze #4 Key**
   - **Order of Operations Challenge Key**
   - **Writing Algebra Equations Key**
   - **Word Problem Chains A, B, and C Keys**

8. **Duplication Materials**
   - COOPERATIVE GROUP WORK RUBRIC — *as needed + one to post (optional)*
   - TALLY — *two per team or as needed (you may need more for **Extension** activities)*
   - PRETEST/POSTTEST — *two class sets*
   - ALGEBRA CHAIN 1 — *class set*
   - PARTIAL MAZE #1 — *one per team*
   - MAZE #1 — *one per team*
   - ALGEBRA CHAIN 2 — *class set*
   - INDIVIDUAL ASSESSMENT CHAINS 1 & 2 — *class set*
   - PARTIAL MAZE #2 — *one per team*
   - MAZE #2 — *one per team*
   - PEER AUDIT REPORT — *three per team*
   - ALGEBRA CHAIN 3 — *class set*
   - PARTIAL MAZE #3 — *one per team*
   - MAZE #3 — *one per team*
   - ALGEBRA CHAIN 4 — *class set*
   - INDIVIDUAL ASSESSMENT CHAINS 3 & 4 — *class set*
   - PARTIAL MAZE #4 — *one per team*
   - MAZE #4 — *one per team*
   - ADDITIONAL PROBLEMS MAZE #4 — *class set*
   - ALGEBRA CHAIN 5 — *class set*
   - INDIVIDUAL ASSESSMENT CHAINS 5 & 6 — *class set*
   - DESIGNING INDIVIDUAL MAZES — *class set*
   - INDIVIDUAL MAZE TEMPLATE — *class set*
   - MAZE DESIGN RUBRIC (4 on a page) — *class set*
   - MARBLE MAZE PATTERN — *one per team*
   - PATTERN FOR BAFFLES — *one per team*
   - MARBLE MAZE TIME RECORD — *one per team*

You will use most of these keys during instruction as students work.

Consider making transparencies of duplication materials or Student Guide pages as visual aids to supplement instruction.

Extensions

- ORDER OF OPERATIONS CHALLENGE — *as needed*
- WRITING ALGEBRA EQUATIONS — *as needed*
- ALGEBRA CHAIN 6 — *class set*
- MAZE #5 — *one per team + transparency*
- WORD PROBLEM CHAIN A — *as needed*
- WORD PROBLEM CHAIN B — *as needed*
- WORD PROBLEM CHAIN C — *as needed*
- PROBLEM-SOLVING FORMAT SAMPLE — *as needed*
- PROBLEM-SOLVING FORMAT — *as needed*
- PROBLEM-SOLVING RUBRIC (2 on a page) — *class set or as needed*

9. **Other Materials**
   - Additional problems for more practice — *as necessary*
   - Brown paper shopping bags — *one per team (optional)*
   - Calculators — *one or more per team (optional)*
   - Centimeter graph paper — *six sheets per team (optional)*
   - Centimeter rulers — *class set*
   - Colored pencils — *class set*
   - Dark Crayons — *one per team*
   - Die — *one*
   - Felt pens, crayons, or markers — *one set per team*
   - Manila drawing paper (12" x 18") — *class set (optional; for mounting individual mazes)*
   - Manila file folders — *one per DUPLICATION page (optional)*
   - Marbles — *one per team*
   - Oaktag (or heavy-weight paper, 12" x 18") — *two per team*
   - Pocket folders or large brown envelopes — *one per team*
   - Scissors — *one per team*
   - Scrap paper — *24 sheets per team*
   - Transparent tape — *one roll per team*
   - Watch/clock with sweep second hand or stop watch — *one per team*

10. **Organizing Materials**
    a. You may choose to duplicate all the materials needed for the unit before starting the unit, or duplicate as you go along. It is a good idea to store each set in its own manila file folder.
    b. Store the duplication sets in the order that they are used. (See **Daily Directions** or **Unit Time Chart**.) If a set is used more than once like the PRETEST/POSTTEST, you may make two separate manila file folders, or just move the folder to its new position after you have used it the first time.

c. The number to be duplicated is a minimum. Make a few extras in case some are lost or must be redone.
d. Be sure to return the originals to the Teacher Guide.

11. **Organizing Team Folders**
    a. Each team will need a pocket folder or large envelope in which to store its daily work, activity sheets, etc. The **Recorder** is responsible for the team folder at the end of the day. If there are more materials than the folder can hold, place them in a large brown paper grocery bag, label, and store in a safe place in your classroom.
    b. Staple two copies of the TALLY and one COOPERATIVE GROUP RUBRIC onto every team folder.
    c. Put one Student Guide into each folder for each team member.

12. **Using the Internet**
    If you have access to the Internet, your students may benefit by looking on the web for information on algebra or mazes.
    a. Before using the Internet, become familiar with your school's Acceptable Use Policy. Always preview any website you make available to your students. If your students do not have classroom access to the Internet, you may access the Internet and build a notebook of information printed off the various websites you locate.
    b. **Interact's Internet Resource List**. Several recommended website addresses are listed on a Resource page available through the Interact web page. To find the **ALGEBRA MYSTERY MAZE** Resource Page, complete the following steps:
        - Connect to the Internet
        - Go to Interact's site at: **www.teachinteract.com**
        - Click the "**Resources**" button
        - Click the "**ALGEBRA MYSTERY MAZE**" link
        - Click any links of interest
        - Click the "**Back**" button to return to Interact's home page
    c. Advise your students that they may find both reliable and unreliable information on the Internet. Suggest that they check source information carefully.

EXTENSIONS

Allowing lagging teams to earn more cms through additional homework assignments makes the final competition more exciting. It levels the playing field.

ALGEBRA MYSTERY MAZE includes a variety of **Extension** activities that enable students to hone their skills while offering individuals and teams the chance to earn extra cms. Use some or all to challenge your students or to allow students to accrue needed cms.

Order of Operations Challenge

Students work in teams to determine how to apply the Order of Operations to a series of numbers so that an equation statement is true.

Writing Algebra Equations

Students translate statements into algebraic equations. For added challenge students write original word problems to match the algebra equations.

ALGEBRA CHAIN 6 and MAZE #5

Students have another opportunity to solve a more complex algebra chain and to compete in a race to solve a three-dimensional maze.

Solving Algebra Word Problem Chains

Students solve algebra word problem chains. For added challenge, students describe their math thinking by completing a PROBLEM-SOLVING FORMAT describing the steps to solving the problem and any insights they realized.

Specific teaching directions begin on page 51. These include Objectives, Materials lists, and Procedures.

1. **Variety of Assessment Tools**
   a. To assess student pre-knowledge of algebra, conduct the PRETEST before starting the activities.
   b. Conduct assessments of student learning throughout the unit.
      - INDIVIDUAL ASSESSMENTS are keyed to the concepts practiced during each Algebra Chain.
      - Use additional specialized assessments to spot-check student learning.
   c. Rubrics included in the unit clarify your expectations for students and set a standard of achievement.
      - Use the COOPERATIVE GROUP WORK RUBRIC throughout the unit to reinforce positive group behavior.
      - Use the MAZE DESIGN RUBRIC to assess student and/or team maze design.
      - Use the WORD PROBLEM RUBRIC to assess how effectively students express math thinking when explaining how they solved problems.
   d. Administer the POSTTEST the day after the *Marble Maze Challenge* or on the last day of the unit to assess student understanding of content.

2. **Individual Assessments**
   So that you will be confident that all your students are learning algebra, each Algebra Chain concept has a corresponding INDIVIDUAL ASSESSMENT to verify student understanding of how to solve algebra equations and word problems.
   a. Each assessment mirrors the types of problems that the team solved in each Algebra Chain.
      - The problems in each assessment area are listed from easiest to most difficult.
      - You may ask your students to work all six in each area or you may expect them to only complete the first three or four, based on the ability of the students in your class.
   b. Encourage all students to complete the INDIVIDUAL ASSESSMENTS on their own.
      - Allow students who struggle with computation to use a calculator.
      - Students who experience difficulty on some individual assessment problems may circle the whole problem and then have a teammate peer teach that problem and initial the answer so that the teacher can see that peer teaching has occurred.
   c. Use INDIVIDUAL ASSESSMENTS to award teams additional cms for each correct problem.

Decide ahead of time if you will allow some or all students to use calculators.

3. **Writing**
   ALGEBRA MYSTERY MAZE includes many opportunities for students to write to clarify their math thinking or to demonstrate what they know. You may use these as informal assessments or as opportunities to earn extra cm.
   a. At any time you may assign a question such as, "What is the first strategy you use after you read an algebra equation?" For a more formal lesson, use the PROBLEM-SOLVING FORMAT **Extension**.
   b. You may also ask students to write short reflection pieces on different aspects of the unit.
      - They may describe which type of problems gave their team trouble and why.
      - They may write whether a maze is fair or not.
      - They may write suggestions for modifying the rules for transferring cms.
      - Students also may evaluate the final maze design. Was it a competitive maze? What changes would their team make if they were to do the activity again?
   c. Consider giving two assessment scores for writing—one for content and one for mechanics. If the mechanical errors are so intrusive or the thoughts so disorganized that you cannot understand what the student is trying to say, give a score of *1—Incomplete* and require the student to rewrite the piece.

TEACHING TIP

You may keep an official copy of each team's TALLY on the bulletin board or in your mark book.

4. **Peer Audits (optional)**
   Several times during this unit, the **Daily Directions** include a *Peer Audit*. This means that each team checks the work of another team, including their measurement of line segments on the most recent maze and the totals on their TALLY.
   a. When one team finds an error in another team's work, they earn extra centimeters. On the other hand, a team with accurate measurements and TALLY totals earns extra centimeters for accurate work.
   b. *Peer Audits* have three purposes.
      First, they cause students to repeat measuring and computation, thereby gaining additional practice.
      Second, they cause students to work more carefully because they don't want other teams to benefit from their mistakes.
      Third, *Peer Audits* greatly decrease the correcting load for you and allow you more time to prepare lessons and/or tutor students who need extra help.
   c. Be certain to check your school policies regarding students correcting other students' work.

If Peer Audits *are not allowed in your district, spot check one or two teams each day. Award cms to teams who have perfect records and deduct cms from teams who have errors.*

5. **What do Rubric Scores Mean?**
Rubrics help teachers and students to describe student work. The student's goal is to create work or perform a skill at an "expected" level to meet a standard. The teacher's goal is to reference a standard to fairly and reliably describe student work or performance.

When completing performance assessments, focus on all "student work." This work is *not* limited to written work. It includes demonstrated skills, oral exchanges, individual and cooperative group behavior, processes, strategies, and any other evidence that proves that the students have learned the targeted content or skill and can apply what they know.

4 — Exemplary — Generally this rating describes work that exceeds the standard for the activity. The descriptor includes words such as "very," "consistently," "complete," "with detail," "actively," and "willingly." Students who earn a "4" demonstrate leadership and knowledge when participating in the unit activities. Their work or performance goes significantly beyond what was asked or required.

3 — Expected — Generally this rating describes work that meets the standard with quality. The descriptors lack some of the positive adjectives of a "4," but this student has mastered the content or skill and can demonstrate his/her understanding in an application setting.

2 — Nearly There — Generally this rating describes work that almost meets the standard. Sometimes inconsistent effort or a misconception of the content will result in a "2" rating. This student needs to try a little harder, or needs to revise his/her work in order to meet the standards described.

1 — Incomplete — Generally this rating describes work that has not yet met the standard in content and/or skill. This student will require more instruction and another opportunity to demonstrate a knowledge or skill, or will require alternative instruction and assessment.

6. **Using Rubrics**
   The philosophy of standards-based assessment and instruction requires that students correct work until it "meets" the standard. At first this may seem problematic with the heavy correcting load most teachers carry. However, once students know that you will not accept work that does not meet your expected standard and will require them to redo it, they begin to do their best the first time. Also, only by warranting that students really do understand content or a skill can you confidently move on to new subject material that builds on what you have taught.
   a. Always post the rubric and carefully go over the details of the rubric before students begin to work to be certain they understand what you expect.
   b. Remind students that a copy of the COOPERATIVE GROUP WORK RUBRIC is attached to the Team Folder. At first you may want to use the rubric daily, but as students become more aware of what you expect, you may use it less frequently.

7. **Standards-based Grading**
   Every student and team has the opportunity to strive for *Exemplary* evaluations regardless of what the rest of the class is doing. For your grade level, determine what students must achieve on the POSTTEST to "meet" the standard of content for this unit.
   a. Correct the tests, and if a student demonstrates enough knowledge of content to "meet" the standard, then award him/her a "*3—Expected*."
   b. If he/she demonstrates more than *Expected*, award a "*4—Exemplary*."
   c. If a student does not demonstrate enough knowledge of content, grade as a 2— or 1—*Incomplete*.
   d. Take the time to determine the misperceptions and re-teach. Insist that they learn the content and allow them to retake the POSTTEST until they earn a "3."

1. **Using Algebra Chains**
   Algebra Chain activities can stand alone as a series of team competitions without using the mazes.
   a. Use any Algebra Chain as a supplement to your regular classroom instruction—just pull out a chain when appropriate. Based on your ongoing classroom instruction, you may begin with any chain activity or lesson to benefit your class.
   b. Use the Algebra Chains periodically to build confidence in individual performance.
   c. The series of Algebra Chains may be shortened to fit your class schedule. Some of the chains are great for review or team assessment and may only take five to fifteen minutes to complete based on your class and its familiarity with the algebra problems.

2. **Optional Schedules**
   Depending on your course objectives, use one of these modified schedules to fit your curricular timeframe.

   Five-day Experience

   Appropriate for students who have learned all of the algebra concepts in your regular program. Do not complete the mazes. Use only the Algebra Chains without Word Problem Chains. Keep score for problems completed correctly.
   Day 1—Introduce rules, establish teams, ALGEBRA CHAIN 1
   Day 2—ALGEBRA CHAIN 2
   Day 3—ALGEBRA CHAIN 3
   Day 4—ALGEBRA CHAIN 4
   Day 5—ALGEBRA CHAIN 5 **and/or** 6

   Six-day Experience

   Appropriate for students who have learned all of the algebra concepts in your regular program. Students will complete the Algebra Chains and the *Marble Maze Challenge.*
   Day 1—ALGEBRA CHAINS 1, 2, and WORD PROBLEM CHAIN A
   Day 2—ALGEBRA CHAINS 3, 4, and WORD PROBLEM CHAIN B; begin 3-d maze box
   Day 3—ALGEBRA CHAIN 5, and WORD PROBLEM CHAIN C, ALGEBRA CHAIN 6 (optional); purchase baffles
   Days 4–5—Assemble maze box, baffles, and test the box
   Day 6—*Marble Maze Challenge*

Eight-day Experience

Appropriate for students who have learned all of the algebra concepts in your regular program. Use both the Algebra Chains and Word Problem Chains and keep score for problems completed correctly. Do not complete the maze activities.

Day 1—Introduce rules, establish teams, ALGEBRA CHAIN 1
Day 2—ALGEBRA CHAIN 2
Day 3—WORD PROBLEM CHAIN A
Day 4—ALGEBRA CHAIN 3
Day 5—WORD PROBLEM CHAIN B
Day 6—ALGEBRA CHAIN 4
Day 7—WORD PROBLEM CHAIN C
Day 8—ALGEBRA CHAIN 5 **and/or** 6

Twenty-day Experience

Incorporate the various **Extensions** into the unit to afford students additional problem-solving practice and experience.

Day 1—Introduce rules, establish teams, ALGEBRA CHAIN 1
Day 2—MAZE #1
Day 3—ALGEBRA CHAIN 2
Day 4—MAZE #2
Day 5—WORD PROBLEM CHAIN A
Day 6—ALGEBRA CHAIN 3
Day 7—MAZE #3
Day 8—WORD PROBLEM CHAIN B
Day 9—ALGEBRA CHAIN 4
Day 10—MAZE #4
Day 11—WORD PROBLEM CHAIN C
Day 12—ALGEBRA CHAIN 5
Days 13–14—*Individual Maze Competition*
Day 15—WRITING ALGEBRA EQUATIONS
Day 16—ALGEBRA CHAIN 6
Day 17—MAZE #5
Days 18–20—*Marble Maze Challenge*

Twenty+ day Experience

Include daily writing reflections activities and spend more time having students explain their math thinking. This will expand your time schedule, **but** research has shown that writing helps students to clarify their thinking and construct new understandings. Allotting more time to writing in this unit may increase overall comprehension of these math concepts.

UNIT TIME CHART

PRE-UNIT	DAY 1	DAY 2	DAY 3	DAY 4
• Determine work areas • Set up Team Folders • Student Guides • COOPERATIVE GROUP WORK RUBRIC • TALLY	• Form and name teams • **Introduction, Roles and Responsibilities** (SG, p3 1, 2) • Take a pretest • PRETEST/ POSTTEST **Teacher Reference** • **Pretest/Posttest Key**	• Assume roles • **Order of operations, Algebra Chain Rules** (SG, p. 2, 8) • Algebra Chain 1 competition • ALGEBRA CHAIN 1 **Teacher Reference** • **Algebra Chain 1 Key** • SG, p. 8 transparency	• **Maze Rules** (SG, p. 3, 8) • Complete Maze #1 • PARTIAL MAZE #1 • MAZE #1	• **Substitution of a numerical value for a variable** (SG) • Algebra Chain 2 competition • ALGEBRA CHAIN 2 • INDIVIDUAL ASSESSMENT CHAIN 1 **Teacher Reference** • **Alg. Chain 2 Key** • **Ind. Assessment Chain 1 Key**
DAY 5	**DAY 6**	**DAY 7**	**DAY 8**	**DAY 9**
• Complete Maze #2 • Complete *Peer Audits* • PARTIAL MAZE #2 • MAZE #2 • PEER AUDIT REPORT	• **Transformations: addition and subtraction** (SG) • Algebra Chain 3 competition • ALGEBRA CHAIN 3 • INDIVIDUAL ASSESSMENT CHAIN 2 **Teacher Reference** • **Alg. Chain 3 Key** • **Ind. Assessment Chain 2 Key**	• Complete Maze #3 • Complete *Peer Audits* • PARTIAL MAZE #3 • MAZE #3 • PEER AUDIT REPORT	• **Transformations: multiplication and division** (SG) • Algebra Chain 4 competition • ALGEBRA CHAIN 4 • INDIVIDUAL ASSESSMENT CHAIN 3 **Teacher Reference** • **Alg. Chain 4 Key** • **Ind. Assessment Chain 3 Key**	• Complete Maze #4 • Complete *Peer Audits* • PARTIAL MAZE #4 • MAZE #4 • ADDITIONAL PROBLEMS MAZE #4 • PEER AUDIT REPORT
DAY 10	**DAY 11**	**DAY 12**	**DAYS 13–14**	**DAY 15**
• **Using reciprocals: fractions and decimals** (SG) • Algebra Chain 5 competition • INDIVIDUAL ASSESSMENT CHAIN 4 • ALGEBRA CHAIN 5 **Teacher Reference** • **Ind. Assessment Chain 4 Key** • **Alg. Chain 5 Key**	• Design and draw individual mazes • INDIVIDUAL ASSESSMENT CHAIN 5 • DESIGNING INDIVIDUAL MAZES • INDIVIDUAL MAZE TEMPLATE **Teacher Reference** • **Ind. Assessment Chain 5 Key**	• Participate in the *Individual Maze Competition* • Student-created mazes • MAZE DESIGN RUBRIC	• Design, build, and test a marble maze • **Marble Maze Challenge** (SG) • MARBLE MAZE PATTERN • PATTERN FOR BAFFLES	• Participate in the *Marble Maze Challenge* • MARBLE MAZE TIME RECORD • PRETEST/ POSTTEST **Teacher Reference** • **Pretest/Posttest Key**

Day 1

Objectives

- Form and name teams
- **Introduction**, **Roles and Responsibilities** (Student Guide, page 1, 2)
- Take a pretest

Materials

- Team Folders — *one per team*
  COOPERATIVE GROUP WORK RUBRIC — *one*
  TALLY — *one*
  Student Guide — *one per team member*
- PRETEST/POSTTEST — *class set*

Teacher Reference

- **Pretest/Posttest Key**

Preparation

1. Assign students to heterogeneous teams and set up team folders. See **Setup Directions #11**, **Organizing Team Folders** (page 9) for suggestions.

2. Designate a work area and an area for each team to store all materials. Three desks side-by-side work best for a work area.

Procedure

1. Announce team assignments and allow 5–8 minutes for students to name their teams. Suggest that they include math terms or maze/mystery words in their team name.

2. Distribute Team Folders and direct students to write their team name on the outside of the folder. Under the team name they should write their individual names.
   a. Teams need their folders every day.
   b. The Recorder is responsible for the folder during class time and organizing the materials inside.
   c. Team Folders are handed in at the end of each class period.

3. Have students take out their Student Guides and write their team name and their own name on the top. Read and discuss with the class the **Introduction** on page 1. Read the **Roles and Responsibilities** on page 2 of the Student Guide.

4. Answer any questions and collect Team Folders.

5. Administer the PRETEST and correct it before the next class.

TEACHING TIP

*If you have decided to use a time schedule other than the one described on the **Unit Time Chart**, take a moment to explain how long the unit will run and what your class will be doing.*

The PRETEST will give you some idea of the students' prior knowledge and also help you gauge how much new learning takes place by the end of the simulation.

Day 2

Objectives

- Assume roles of Designer, Measurer, and Recorder
- **Order of operations**, **Algebra Chain Rules** (Student Guide, page 2, 8)
- Algebra Chain 1 competition

Materials

- ALGEBRA CHAIN 1 — *class set*
- TALLY — *one per team*

Teacher Reference

- Student Guide, page 8 — *transparency (optional)*
- **Algebra Chain 1 Key**

Preparation

1. If the PRETEST reveals that your students need a lot of instruction, put together materials to supplement the brief lessons in the Student Guide.

2. Create a transparency of page 8 of the Student Guide to help you describe how to solve chain activities.

Procedure

1. Distribute Team Folders and assign roles. To begin, ask the youngest team member to be the Designer and the oldest to be the Recorder. The roles will rotate only on days that teams solve an Algebra Chain. Designer rotates to become Measurer who rotates to become Recorder who rotates to become Designer.

2. Have students open their Student Guides to page 2 and teach or review the *Order of operations* rules.
   a. Write similar problems from the math textbook on the chalkboard to provide more practice.
   b. Spend a few minutes on the sample algebra word problem.
   c. If your students need more practice than what you find in the Student Guide, use other materials from your math text.

3. Go over the **Algebra Chain Rules** on page 2.
   1. Solve each problem following *Order of operations* procedures.
   2. All team members complete each **Algebra Chain** problem but only the **Recorder's** work will be checked for accuracy. (Sharing information is vital to team success.)
   3. Earn centimeter lengths (cms) for every correct answer on the **Algebra Chain** problems.
   4. Earn additional cms by being quick to solve the **Algebra Chain** problems. (first place = +10 cms; second place = +9 cms, third place = +8 cms, etc.)

If there are four students per team, the fourth role, "Member", rotates to become Measurer. Roles cycle as follows: Designer to Member to Measurer to Recorder to Designer.

Students and teachers are familiar with problems like this. In arithmetic exercises we called these 2-step word problems. Note that in algebra, students write an equation and substitute a letter for the answer.

Algebra Chain Rules
Student Guide Text

DAILY DIRECTIONS
DAY 2

4. Using **How to Solve an Algebra Chain** on page 8 of the Student Guide, show students how to apply these rules to complete an Algebra Chain.
   a. For the sample, the first unknown, z, equals 4.
   b. For all Algebra Chain competitions you will give the value for the initial unknown in the first problem.
   c. Students use the answer of the first equation to represent the unknown in the second equation, and the answer to the second equation to represent the unknown in the third.
   d. Remind students that only the Recorder's answers will be checked for accuracy.
5. Advise students that making an error can cost their team a lot of time, so it is imperative that the <u>whole</u> team work on the equations individually and then compare answers. This will maximize their chances of finding an error before starting a new problem with the wrong value.
6. Announce that for Algebra Chain 1 the multiplier is **<u>5</u>**. This means each team will earn +5 cms for every correct answer. However, teams will not earn cms for any incorrect answers that you circle.
7. Teams will also earn bonus cms depending on the order that they complete the chain. The first place team earns +10 cms, the second place team earns +9 cms, third place earns +8 cms, and so forth.
8. Ask for and answer any questions about the Algebra Chain competition. Direct the Recorders to sit in the middle, between the other two team members.
9. Tell students that you will now distribute ALGEBRA CHAIN 1 to each student, face down. Instruct students to not turn the pages over until you give the word.
10. Direct students to write their name on the back of ALGEBRA CHAIN 1. When all students have written their names on the chain tell students to turn over their papers. Announce the value of the variable (**<u>z = 3</u>**) and tell students to begin solving equations.

TEACHING TIP

Algebra Chain solving is a competitive activity. No team should have the unfair advantage of studying the problems in advance.

11. Immediately begin to walk around the room to monitor each team's progress on the chain. Use the **Algebra Chain 1 Key** and check students as they work.
    a. Look only at the Recorder's paper and only circle errors on the Recorder's paper.
    b. When you see an error in the chain, circle only the first incorrect answer.
    c. This signals that the team must redo that problem, and all following problems based on that incorrect answer.
    d. If all the answers are correct so far, just say "Okay" and move on.
    e. A team has succeeded in solving the chain when the last answer box has the correct answer (**224**).

12. As teams finish, mark each Recorder's page with a number corresponding to their order of finish (first, second, third, etc.)

13. Award cms for correct problems by multiplying the number of correct answers times today's multiplier (**+5**). Remember, circled answers do not earn any cms.

14. When all teams have finished, direct students to look at **How to Complete a Tally** on page 8 of the Student Guide. Describe how to enter scores earned.

15. The Designer is responsible for the TALLY. All members of the team will assume the role of Designer at some point, so the other members should check the Designer's work to make sure that he/she completed the entries correctly.

16. Direct students to put all ALGEBRA CHAIN 1 worksheets (Recorder's worksheet on top) and Student Guides into the Team Folders.

17. Review the papers to see how other team members solved the problems. Check each TALLY to see that the team Designer completed it correctly.
    a. If any team's Designer did not complete the TALLY correctly, indicate the error.
    b. Do not assess any penalties for errors today because students are still learning the process.

Because time is so important, you cannot spend time helping any team solve a problem. You must stay available to catch errors on other team papers as soon as they occur.

Day 3

Objectives

- **Maze Rules** (Student Guide, page 3, 8)
- Complete Maze #1

Materials

- PARTIAL MAZE #1 — *one per team*
- MAZE #1 — *one per team*
- Centimeter ruler — *one per team*

Teacher Reference

- Student Guide, page 8 — *transparency (optional)*

Procedure

1. Put teams into three-desk work area. On Maze days, the Measurer sits in the center seat.

2. Distribute Team Folders. For any team whose Designer did not complete the TALLY correctly, be certain that the team knows the correct number of cms they earned from Algebra Chain 1 before they begin PARTIAL MAZE #1.

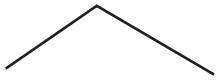
3. Ask students how they might use a partial maze to determine the shortest route. There is no one, correct answer. There are many strategies. Sharing strategies is a good way to increase interest in solving the mazes.

4. Review **Maze Rules** on page 3 of the Student Guide. Students must follow the established rules:
   1. Use the cms your team earns completing **Algebra Chains** to move through a maze.
   2. As a team, decide the route through the maze.
   3. Commit to a maze starting point by circling a symbol or letter.
      a. The team with the highest number of cms selects its starting point first.
      b. The first team to claim a starting point collects 5 cms from all teams who choose the same starting point.
      c. If your team selects a starting point already selected by another team, you must pay that team 5 cms.
      d. You may select another vacant starting point if you do not want to expend any cms.

Student Guide Text

Students may only use the cms that they have earned so far to navigate this maze. They cannot "borrow" cms from expected future gains.

4. **Designers** lightly sketch the path through the maze. Be as efficient as possible.
   a. Draw only line segments—no curved lines.
   b. No line segment may be shorter than 0.2 cm.
   c. No drawn line may touch a maze wall.
5. **Measurers** draw the official route using a ruler.
   a. Measure the line segment lengths (rounded to nearest tenth of a cm).
   b. Write measurements on or next to each segment (for example 2.3 cm).
   c. Directional changes on the maze must form an angle.



6. **Recorders** add up total cms used and report to the Designer.
7. **Designers** maintain the TALLY.
   a. Record the total cms earned, deducted, or used on the **Tally** before starting a new maze.
   b. Your team *must stop* navigating when you have used up all cms earned so far.
   c. It is possible that you may not have enough cms to complete the maze on this day.
8. Earn additional cms by maintaining accurate records and measurements.
   (Accuracy earns +10 cms; Errors earn a deduction of –5 cms *per error*.)

5. Use a transparency of Student Guide page 8 to explain how to mark the pathway on a complete maze by reviewing **How to Navigate a Maze**.

6. Distribute one copy of PARTIAL MAZE #1 to each team and ask them to study it.

7. When each team has decided where they want to start, ask them to commit to a starting location by circling the shape that indicates their starting point.

Strongly suggest that the Designer draw the route very lightly because it may be necessary to take another path.

*Designer will enter that total in the **Cms used** column on the TALLY.*

Stress that the teams must stop navigating the maze when they have used up all of their earned cms. They will be able to complete the maze later. The maze navigation is not a race.

8. Review the rules regarding the order that teams choose:
   a. The first-place team (the one with the greatest number of cms earned so far) claims the first starting point. Write that information on the board.
   b. Next the second-place team states its preferred starting point. If the location has already been claimed by the first-place team, then they must transfer 5 cms to the first team.
   c. The selection of starting points continues until all the teams have chosen. Remember, the team that first claims a starting symbol collects 5 cms from any other teams who choose the same symbol.
   (Note, a team can choose to switch their starting point if they do not want to pay the other team, but this is a limited option since there are only four starting points.)
   d. Direct the Recorder to record the plus or minus cms on the TALLY before solving the maze.

9. Remind students that you will deduct cms from their TALLY if the line segments are carelessly drawn or if their measurements are inaccurate. All team members should check the team's work.

10. When all teams are committed to a starting point, and you have answered all procedural questions, distribute one MAZE #1 to each team. Direct them to circle their starting point.

11. As soon as everyone is ready, give the signal to start. Teams must start at their circled starting point and draw a path to any end point.

12. When they finish, they should put their completed maze in their Team Folder and return the folder to you. Check each team's TALLY for accuracy before the next class.

It may appear that teams who start at the circle have no way to reach the nearest end point. This is not an error in the maze; it is a means to teach the students to look for alternative solutions when solving problems.

Day 4

Objectives

- **Substitution of a numerical value for a variable** (Student Guide, page 3)
- Algebra Chain 2 competition
- Individual assessment applying *Order of operations*

Materials

- ALGEBRA CHAIN 2 — *class set*
- INDIVIDUAL ASSESSMENT CHAIN 1 — *class set*
- Calculators — *one per team (optional)*

Teacher Reference

- **Algebra Chain 2 Key**
- **Individual Assessment Chain 1 Key**

Procedure

1. Distribute Team Folders and rotate roles. **Designer** rotates to become **Measurer** who rotates to become **Recorder** who rotates to become **Designer**. Put teams into three-desk working area with new Recorder in the center.

2. Discuss any difficulties or errors students made when completing MAZE #1 and the TALLY before starting today's lesson.

3. Direct students to page 3 of the Student Guide. Review the teaching instructions for Algebra Chain 2: **Substitution of a numerical value for a variable**.
   a. Write similar problems from the math textbook on the chalkboard to provide more practice.
   b. Spend a few minutes on the sample algebra word problem.
   c. If your students need more practice than what you find in the Student Guide, use other materials from your existing math text.

4. If necessary, review the **Algebra Chain Rules** (Student Guide, page 2). Announce that for Algebra Chain 2 the multiplier is **7**. This means each team will earn +7 cms for every correct answer. Again, teams will not earn cms for any incorrect answers that they circle. Distribute ALGEBRA CHAIN 2 (face down), and when all teams are ready (names on the backs of papers), announce the value of the variable (**b = 3**) and allow students to begin to solve the equations.

Remember, if there are four students per team, the fourth role, "Member", rotates to become Measurer. Roles cycle as follows: Designer to Member to Measurer to Recorder to Designer.

Students and teachers are familiar with problems like this. In arithmetic exercises students figured these out sometimes using pictures, but did not necessarily use equations. Note that in algebra, students must write an algebraic equation to describe what they know. They substitute a letter for an unknown value until the value is announced or revealed. Once they know the value, they can solve the equation.

DAILY DIRECTIONS
DAY 4

TEACHING TIP

Direct the team with an error to quickly correct the problem and rework the problems that follow. Calculators may be appropriate for some teams.

5. Immediately begin to walk around the room to monitor each team's progress on the chain. Use the **Algebra Chain 2 Key** and check students as they work.
   a. Look only at the Recorder's paper and only circle errors on the Recorder's paper.
   b. When you see an error in the chain, circle only the first incorrect answer.
   c. This signals that the team must redo that problem, and all following problems based on that incorrect answer.
   d. If all the answers are correct so far, just say "Okay" and move on.
   e. A team has succeeded in solving the chain when the last answer box has the correct answer (**12**).

6. As teams finish, mark each Recorder's page with a number corresponding to their order of finish (first, second, third, etc.) Award bonus cms. Teams earn bonus cms based on how they finish: first = +10 cms, second = +9 cms, and third = +8 cms, etc.

7. Award cms for correct problems by multiplying the number of correct answers times today's multiplier (**+7**). Remember that circled answers do not earn any cms.

8. When all teams are finished with ALGEBRA CHAIN 2, direct students to the back page of the Student Guide. Review **How to Complete a Tally**. Remind teams that the Designers maintain the team's TALLY.

9. Allow time for any team who has not finished MAZE #1 to use the cms earned today to complete the first maze.
   a. Recorders total up the cms used.
   b. Designers record the cms and adjust the totals on the TALLY.
   c. Remind students that you will be checking each team's TALLY and will assess penalties for errors.
   d. When all teams have finished their accounting, collect the Team Folders.

10. Direct students to put all ALGEBRA CHAIN 2 worksheets (Recorder's worksheet on top) and Student Guides into the Team Folder.

11. If time remains, separate the desks and distribute INDIVIDUAL ASSESSMENT CHAIN 1. If no time remains, administer this assessment of mastery of the *Order of operations* as the first activity of Day 5.

12. Before the next class meeting, review the papers to see how other team members solved the problems. Check each TALLY to see that Designer completed it correctly.
    a. Award +10 cms for perfect records.
    b. Deduct –5 cms for every error you find.

13. If any teams are falling behind in total cms earned, consider assigning an **Extension** activity to enable them to stay in the competition.

Day 5

Objectives

- Complete Maze #2
- Complete *Peer Audits*

Materials

- PARTIAL MAZE #2 — *one per team*
- MAZE #2 — *one per team*
- PEER AUDIT REPORT — *one per team*
- Centimeter ruler — *one per team*

Teacher Reference

- Student Guide, page 8 — *transparency (optional)*

Procedure

1. Put teams into three-desk work area. On Maze days, the Measurer sits in the center seat.

2. Distribute the Team Folders. Ask teams to see if you determined that their records were accurate or if they had any errors. The team must help the Designer to correct any errors in cms totals. The team must know the correct number of cms they earned from Algebra Chain 2 before they begin PARTIAL MAZE #2.

3. Announce that from now on, classmates will conduct *Peer Audits* of other teams' work. However, you will spot-check records each night.

4. Distribute PARTIAL MAZE #2. This maze shows four different rooms with four different entrances.

5. Students *do not* have the opportunity to choose a starting point on MAZE #2. Team starting points are determined by their chosen path on MAZE #1. They must start at the letter (*m, y, k,* or *z*) that their team passed on MAZE #1.

6. However students *do* have the opportunity to choose which room they will enter. They can choose to enter any room regardless of their starting point. On the partial maze, teams must circle the shape *(square, star, circle,* or *triangle)* that leads to the room that they *plan to enter* once they get the complete maze.

Be certain that your school does not have policies forbidding students from correcting other students' work. If it does, you will have to correct all the teams' work.

7. Ask the team that came in first on ALGEBRA CHAIN 2 to claim the shape that leads to the room that they plan to enter.
   a. Any other team that wants to enter that same room must transfer 5 cms to the first team that claimed that shape.
   b. Ask teams to record positive and negative cms (transfers) on their TALLY.

8. If necessary, review **Maze Rules** on page 3 of the Student Guide and **How to Navigate a Maze** on page 8 of the Student Guide.

9. Distribute MAZE #2 and direct each team to circle their starting point and circle the shape indicating which room they plan to enter on the completed maze.

10. Students may use any and all cms earned previously to navigate the second maze.

11. Note: it is possible that some or all teams may not have enough cms to complete the maze. They should stop when their cms are used up and only continue when they earn more cms.

12. **Writing (optional)**
    Ask students to write whether they think that the method of transferring cms is fair or not. They may make suggestions for modifying the rules for transferring cms.

13. In the time remaining ask teams to conduct a *Peer Audit*. Distribute a PEER AUDIT REPORT to each team.
    a. Each team exchanges its MAZE #2 and TALLY with another team.
    b. The Measurer from each team re-measures the line segments on MAZE #2.
    c. The Recorder checks the total cms used.
    d. The Designer checks the TALLY entries.
    e. Allow students to use calculators for auditing. (Other members besides the Designer may need calculators.)

Match the first team that finished a chain with the second team to finish. Continue matching teams as they finish their Algebra Chains.

14. Procedures for a *Peer Audit*:
    a. Allow line segment measurements that are within ±0.3 cm.
    b. The totals recorded on the TALLY should be accurate.
    c. If both the measurements and records are accurate, award +5 cms for each.
    d. An auditing team gains +5 cms for every mistake it finds in measurements or TALLY totals.
    e. If two teams disagree on the numbers, allow a third team to measure or tell them to write their results and you will check the measurements later.

15. Teams prepare a PEER AUDIT REPORT.
    a. If the records are without errors, the Recorder of the auditing team certifies the records as accurate by signing the PEER AUDIT REPORT.
    b. If the auditing team finds an error, they write the location of the error (either ***Maze*** or ***Tally***) and write a short description such as *Third Line segment is 3.7 cms, not 2.7 cms.*
    c The auditing team must have another team or the teacher confirm their error finding. If the error finding is rejected, the auditing team must transfer 5 cms to the team they were auditing.

16. If time still remains, direct students to practice algebra equations or word problems in their texts that are similar to those in ALGEBRA CHAINS 1 and 2.

17. Collect Team Folders.

Day 6

Objectives

- **Transformations involving addition and subtraction** (Student Guide, page 4)
- Algebra Chain 3 competition
- Individual assessment applying *Substitution of a numerical value for a variable*

Materials

- ALGEBRA CHAIN 3 — *class set*
- INDIVIDUAL ASSESSMENT CHAIN 2 — *class set*

Teacher Reference

- **Algebra Chain 3 Key**
- **Individual Assessment Chain 2 Key**

Procedure

1. Distribute Team Folders and rotate roles. **Designer** rotates to become **Measurer** who rotates to become **Recorder** who rotates to become **Designer**. Put teams into three-desk working area with new Recorder in the center.

2. Direct students to page 4 of the Student Guide. Review the teaching instructions for Algebra Chain 3: **Transformations involving addition and subtraction**.
   a. Write similar problems from the math textbook on the chalkboard to provide more practice.
   b. Spend a few minutes on the sample algebra word problem.
   c. If your students need more practice than what you find in the Student Guide, use other materials from your existing math text.

3. Distribute ALGEBRA CHAIN 3 (face down), and announce that the multiplier value is **3**. When all teams are ready (names on the backs of the papers), announce the value of the unknown (**z = 9**) and allow students to begin to solve the equations.

4. Follow the earlier procedure for checking the Recorders' papers as they work on solving the chain equations. (See **Daily Directions** for **Day 4**, #5 on page 26, for itemized steps.)

5. As teams finish, write the order of finish on each paper —first, second, third, etc.

TEACHING TIP

If your students cannot add or subtract decimals or fractions with like denominators they will have difficulty with ALGEBRA CHAIN 3. Ask students to round the numbers to the nearest whole number to solve the problems. Prepare your own answer key.

TEACHING TIP

Formerly, students probably used pictures to solve word problems like this in arithmetic exercises. Today they will realize how much easier problems like these are to solve using algebra equations.

6. The Algebra Chain 3 multiplier value is 3. Award **+3** cms for each correct problem by multiplying the number correct times the multiplier. Do not award cms for any circled problems.
7. Award teams cms based on the order in which they finish: first = 10 cms, second = 9 cms, and third = 8 cms, etc.
8. The Designer should record score, multiplier, and cms earned on TALLY.
9. Allow time for any team who has not finished MAZE #2 to use the cms earned today to complete the maze.
   a. Recorders total up the cms used.
   b. Designers record the cms and adjust the totals on the TALLY.
   c. Remind students to check their work carefully because there will be another *Peer Audit* on Day 7.
10. Direct students to put all ALGEBRA CHAIN 3 worksheets (Recorder's worksheet on top) and Student Guides into the Team Folder. Collect Team Folders when everyone is finished.
11. If time remains, separate the desks and distribute INDIVIDUAL ASSESSMENT CHAIN 2. If no time remains, administer this assessment of mastery of substitution of a numerical value for a variable as the first activity of Day 7.
12. If your class will not conduct a *Peer Audit* on Day 7, review the papers prior to the next class. Check each TALLY to see that the Designer completed it correctly.
    a. Award +10 cms for perfect records.
    b. Deduct –5 cms for every error you find.

Day 7

Objectives

- Complete Maze #3
- Complete *Peer Audits*

Materials

- PARTIAL MAZE #3 — *one per team*
- MAZE #3 — *one per team*
- PEER AUDIT REPORT — *one per team*
- Centimeter ruler — *one per team*
- Die — *one*

Teacher Reference

- Student Guide, page 8 — *transparency (optional)*

Procedure

1. Put teams into three-desk work area. On Maze days, the Measurer sits in the center seat.

2. Distribute Team Folders. For any team whose Designer did not complete the TALLY correctly, be certain that the team knows the correct number of cms they earned from Algebra Chain 3 before they begin PARTIAL MAZE #3.

3. Distribute PARTIAL MAZE #3 and ask each team to study it. Teams start at the shape that they passed at the entrances to the rooms for MAZE #2 (*triangle*, *star*, *circle*, or *square*). Teams claim their starting point based on how they placed finishing ALGEBRA CHAIN 3. (First place claims their starting symbol first, then second place, then third place, etc.)

4. MAZE #3 offers an additional opportunity for students to strategize as they claim their starting points.
   a. Any team can claim a different starting shape at a cost of 5 cms.
   b. At their turn, they may subtract 5 cms from their total and claim any shape that is not yet claimed. That shape becomes their new starting point.
   c. If subsequent teams have or also choose that starting symbol, then they must transfer 5 cms to the team that bought (claimed) that starting point first.

5. Direct Designers to record positive and negative transfer of cms on their team's TALLY.

6. At this point, each team Recorder must roll a die. An odd or even number roll determines whether the team must follow the odd or even arrow's direction on MAZE #3. Teams circle the odd or even direction on PARTIAL MAZE #3, thus committing to a pathway through MAZE #3.
7. Distribute MAZE #3 and direct each team to circle their starting point and the odd or even arrow.
8. Students may use cms earned previously to navigate MAZE #3. Team members should follow the same routine as for MAZES #1 and #2. If necessary, review the **Maze Rules** in the Student Guide (page 3), **How to Navigate a Maze** (page 8), and the **Daily Directions** for **Day 3** (beginning on page 22).
9. Note: it is possible that some or all teams may not have enough cms to complete the maze. They should stop when their cms are used up and only continue when they earn more cms.
10. As teams finish, direct them to carefully check their TALLY records and MAZE #3 measurements because the next activity is a *Peer Audit*.
11. In the time remaining ask teams to conduct a *Peer Audit*. Distribute a PEER AUDIT REPORT to each team.
    a. Each team exchanges its MAZE #3 and TALLY with another team.
    b. The Measurer from each team re-measures the line segments on MAZE #3.
    c. The Recorder checks the total cms used.
    d. The Designer checks the TALLY entries. Allow students to use calculators for auditing.
12. Procedures for a *Peer Audit*:
    a. Allow line segment measurements that are within ±0.3 cm.
    b. The totals recorded on the TALLY should be accurate.
    c. If both the measurements and records are accurate, award +5 cms for each.
    d. An auditing team gains +5 cms for every mistake it finds in measurements or TALLY totals.
    e. If two teams disagree on the numbers, allow a third team to measure or tell them to write their results and you will check the measurements later.
13. Collect Team Folders.

Day 8

Objectives

- **Transformations involving multiplication and division** (Student Guide, page 5)
- Algebra Chain 4 competition
- Individual assessment applying *Transformations involving addition and subtraction*

Materials

- ALGEBRA CHAIN 4 — *class set*
- INDIVIDUAL ASSESSMENT CHAIN 3 — *class set*

Teacher Reference

- **Algebra Chain 4 Key**
- **Individual Assessment Chain 3 Key**

Procedure

1. Distribute Team Folders and rotate roles. Designer rotates to become Measurer who rotates to become Recorder who rotates to become Designer. Put teams into three-desk working area with new Recorder in the center.

2. Direct students to page 5 of the Student Guide. Review the teaching instructions for Algebra Chain 4: **Transformations involving multiplication and division**. If the original problem shows a whole number times the unknown, i.e., 4n, then the student should divide both sides of the equation by 4.

5. Distribute ALGEBRA CHAIN 4 (face down), and announce that the multiplier value is **2**. When all teams are ready (names on the backs of the papers), announce the value of the unknown (**z = 72**) and allow students to begin to solve the equations.

6. Follow the earlier procedure for checking the Recorders' papers as they work on solving the chain equations. (See **Daily Directions** for **Day 4**, #5 on page 26, for itemized steps.)

7. As teams finish, write the order of finish on each paper—first, second, third, etc. Award teams cms based on how they finish: first = 10 cm, second = 9 cm, and third = 8 cm, etc.

8. The Algebra Chain 4 multiplier value is 2. Award cms by multiplying the number of correct problems by **+2**.

9. The Designer should record score, multiplier, and cms earned on TALLY.

Students are actually multiplying by the reciprocal, but at this point, it is easier for them to understand they can divide both sides of the equation by the same number to isolate the n. *Students learn about reciprocals in ALGEBRA CHAIN 5.*

10. Allow time for any team who has not finished MAZE #3 to use the cms earned today to complete the maze.
    a. Recorders total up the cms used.
    b. Designers record the cms and adjust the totals on the TALLY.
    c. Remind students to check their work carefully because there will be another *Peer Audit* on Day 9.

11. Direct students to put all ALGEBRA CHAIN 4 worksheets (Recorder's worksheet on top) and Student Guides into the Team Folder. Collect Team Folders when everyone is finished.

12. If time remains, separate the desks and distribute INDIVIDUAL ASSESSMENT CHAIN 3. If no time remains, administer this assessment of mastery of transformations involving addition and subtraction as the first activity of Day 9.

13. If your class will not conduct a *Peer Audit* on Day 9, review the papers prior to the next class. Check each TALLY to see that the Designer completed it correctly.
    a. Award +10 cms for perfect records.
    b. Deduct –5 cms for every error you find.

Day 9

Objectives

- Complete Maze #4
- Complete *Peer Audits*

Materials

- PARTIAL MAZE #4 — *one per team*
- MAZE #4 — *one per team*
- ADDITIONAL PROBLEMS MAZE #4 — *class set*
- PEER AUDIT REPORT — *one per team*
- Centimeter ruler — *one per team*

Teacher Reference

- Student Guide, page 8 — *transparency (optional)*

Procedure

1. Put teams into three-desk work area. On Maze days, the Measurer sits in the center seat.

2. Distribute Team Folders and PARTIAL MAZE #4 and ask each team to study it.
   a. Remind students that their goal is to maximize the cms they earn during the unit.
   b. A large **Cms remaining** total on their TALLY will enable them to draw and solve more complex mazes later.

3. There are many possible maze paths for each starting point. In this maze teams do not necessarily take the shortest route.
   a. Every letter on MAZE #4 represents an additional problem that a team might solve to earn additional cms.
   b. Each team needs time to discuss whether they wish to try to touch a lot of letters and gain additional algebra problems to solve, or try to arrange a trail that touches few letters and uses the least amount of cms.
   c. The line segments must touch a letter to get an additional algebra problem to solve.
   d. A team earns +3 cms for every problem worked correctly.
   e. A team loses –4 cms for every problem that is incorrect.
   f. Team strategy and confidence will dictate to what degree the team tries to touch letters or avoid them.
   g. After the discussion, teams circle a tentative starting point.

DAILY DIRECTIONS
DAY 9

4. The team that first successfully completed ALGEBRA CHAIN 4 claims its starting point (shape) first.
   a. At their turn, the other teams can choose an unoccupied starting point (shape) at no penalty even if they previously committed to a different shape.
   (Example: if team A chose a *star* and team B is second—and also committed to a *star*—team B can shift to a *square*.)
   b. Teams continue to choose shapes until all shapes are claimed.
   c. Any remaining teams who committed to those starting points must transfer 5 cms to the team that claimed that shape first.

5. Ask Designers to record positive and negative cms on the TALLY. Distribute MAZE #4.

6. Teams may use cms earned previously as well as cms they earn while solving additional problems in the maze to navigate MAZE #4. They should follow the same routine as for earlier mazes. Refer students to the Student Guide, page 3 and page 8.

7. Note: it is possible that any or all teams may not have enough cms to complete the maze.
   a. They should stop when their cms are used up and only continue when they earn more cms.
   b. Remind teams that they can earn extra cms immediately by designing a path to touch more letters in the maze and correctly solving additional algebra problems.

8. Teams show you the number of letters that the maze path touched and you give them ADDITIONAL PROBLEMS MAZE #4. Circle the last problem they can solve on the sheet.

9. Teams work the number of additional problems starting with problem #1 and solving them in consecutive counting order. Teams must attempt to solve as many problems on the ADDITIONAL PROBLEMS MAZE #4 as the number of letters they touched with their path.

10. Teams call the teacher when they are finished with the extra problems.

You may check the additional problems and award the bonus cms as teams finish or you may correct the problems later. The exception to later is when a team runs out of cms to navigate the maze and needs the cms immediately.

11. If there is sufficient time after all teams finish, conduct another *Peer Audit*. Distribute a PEER AUDIT REPORT to each team.
    a. Each team exchanges its MAZE #3 and TALLY with another team.
    b. The Measurer from each team re-measures the line segments on MAZE #3.
    c. The Recorder checks the total cms used.
    d. The Designer checks the TALLY entries.
    e. Allow students to use calculators for auditing. (Other members besides the Designer may need calculators.)

12. If no time remains, you must check all team work and records before the students begin to design their independent mazes. The more cms a team has, the more difficult a maze they can design, and the more cms they have to navigate another student's maze.

13. Collect Team Folders and check before the next class.

See the Daily Directions for Day 7 on page 34 for specific steps.

Day 10

Objectives

- Individual assessment applying *Transformations involving multiplication and division*
- **Using reciprocals to solve algebraic equations containing fractions and decimals** (Student Guide, page 6)
- Algebra Chain 5 competition

Materials

- INDIVIDUAL ASSESSMENT CHAIN 4 — *class set*
- ALGEBRA CHAIN 5 — *class set*

Teacher Reference

- **Individual Assessment Chain 4 Key**
- **Algebra Chain 5 Key**

Procedure

1. Before starting class, separate desks and administer the INDIVIDUAL ASSESSMENT CHAIN 4. Collect when everyone is finished.

2. Distribute Team Folders and rotate roles. Put teams into three-desk working area with new Recorder in the center.

3. Review the concept of *reciprocal*. If students have forgotten what reciprocals are and how they help to solve algebra equations, use these directions.
   a. Introduce a reciprocal by showing students examples and letting them see what a reciprocal is. For example, tell students that $\frac{3}{2}$ is a reciprocal of $\frac{2}{3}$, $\frac{7}{5}$ is a reciprocal of $\frac{5}{7}$, and $\frac{1}{2}$ is the reciprocal of $\frac{2}{1}$.
   b. Lead students to discover that to create a reciprocal of a fraction, they must reverse the positions of the numbers in the numerator and denominators. (i.e., $\frac{3}{5}$ and $\frac{5}{3}$)
   c. Today's lesson focuses on the reciprocals of whole numbers or numbers with one in the numerator. If a number is a whole number, the students must put 1 in the denominator and then create the reciprocal. (i.e., $\frac{4}{1}$ and $\frac{1}{4}$). If the number has one in the numerator, then the student should multiply by the number in the denominator.
   c. Demonstrate that when you multiply a number by its reciprocal, the result is 1. Demonstrate how $\frac{1}{8} \times \frac{8}{1} = 1$. Give as many examples as necessary.
   d. Remind them that they must always multiply BOTH SIDES of the equation by the reciprocal!

4. Have students turn to page 6 in the Student Guide. Use the sample problems to show how to use a reciprocal to solve algebraic equations containing fractions and decimals. Review the sample word problems and give more practice from other math texts if necessary.

5. Distribute ALGEBRA CHAIN 5 (face down), and announce that the multiplier value is **3**. When all teams are ready (names on the backs of the papers), announce the beginning value of the unknown (**z = 32**) and allow students to begin to solve the equations.

6. Follow the earlier procedure for checking the Recorders' papers as they work on solving the chain equations. (See **Daily Directions** for **Day 4**, #5 on page 26, for itemized steps.)

7. As teams finish, mark each Recorder's page with a number corresponding to their order of finish (first, second, third, etc.) Award bonus cms. Teams earn bonus cms based on how they finish: first = +10 cms, second = +9 cms, and third = +8 cms, etc.

8. The Algebra Chain 5 multiplier value is 3. Award cms for correct problems by multiplying the number correct times **+3**.

9. The Designer should record score, multiplier, and cms earned on TALLY.

10. Allow time for any team who has not finished MAZE #4 to use the cms earned today to complete that maze and record the cms that they use on the TALLY.

11. Remind students that you will be checking each team's TALLY and will assess penalties for errors. Ask teams to organize all the papers in their Team Folders and collect when everyone is finished.

Remind students of the connection between $\frac{1}{4}$, 0.25, and 25% and other common fractions and decimals. Sometimes problems are easier to solve if they convert the decimal into a simple fraction. i.e., 0.125 = $\frac{1}{8}$.

TEACHING TIP

If your students will benefit from more problem solving, consider adding an extra day to the unit. Have students complete the INDIVIDUAL ASSESSMENT CHAIN 5, then introduce ALGEBRA CHAIN 6, MAZE #5, and INDIVIDUAL ASSESSMENT CHAIN 6 before they begin designing individual mazes.

Day 11

Objectives

- Individual assessment applying *Using reciprocals to solve algebraic equations containing fractions and decimals*
- Design and draw individual mazes

Materials

- INDIVIDUAL ASSESSMENT CHAIN 5 — *class set*
- DESIGNING INDIVIDUAL MAZES — *class set or one per team and/or transparency*
- INDIVIDUAL MAZE TEMPLATE — *class set*
- MAZE DESIGN RUBRIC (4 on a page) — *class set*
- Centimeter ruler — *class set*
- Manila drawing paper (12" x 18") — *class set (optional; for mounting individual mazes)*

Teacher Reference

- **Individual Assessment Chain 5 Key**

Procedure

1. As soon as students enter the room, separate the desks and distribute the INDIVIDUAL ASSESSMENT CHAIN 5.
2. Collect assessments when all students have finished.
3. Cluster the team desks together, but separate them enough to enable students to work independently.
4. Direct students to the **Introduction** on page 1 of the Student Guide. Point out that they have successfully completed **Solving Algebra Chains** and **Navigating Mazes**. Call their attention to **Designing Individual Mazes**. Students are still part of their team, but will work individually.
5. Distribute DESIGNING INDIVIDUAL MAZES. Review the **Design Rules** with students.
   a. Students draw their mazes using the INDIVIDUAL MAZE TEMPLATE.
   b. The total in the **Cms remaining** column of the team's TALLY equals the **cms available** to draw the maze walls (i.e., if a team has 100 in the **Cms remaining** column, all three members of the team may use 100 cms each).

TEACHING TIP

If a team is so far behind that they do not have enough cms to create or solve a maze, just "give" them an amount that allows them to still stay in the competition without displacing other teams who earned the cms.

c. Measure and label all inside walls of the maze. Compute the total length of all the walls to be certain that they do not exceed the total **cms available**. Students cannot exceed that number of cms in the length of their mazes.
d. Write their name and team name on the back of the maze.

6. Review the **Maze Design Rubric** section with the students. Let them know that you will evaluate their work using this rubric.

7. Distribute the INDIVIDUAL MAZE TEMPLATES. Emphasize that students are to create the most challenging maze they can. Their goal is to cause members of other teams to expend as many cms as possible when they solve their maze. Answer any questions.

8. **Designing Individual Mazes (Optional Approach)**
If the **Cms remaining** TALLY totals at the end of the contest are so different that it gives one or two teams too great an advantage, use the following format for creating the mazes:
   a. Allow all students to use the same number of cms (e.g., 150) to build a maze on the INDIVIDUAL MAZE TEMPLATE. This makes the maze creation more fair.
   b. After randomly switching mazes and identifying a starting number allow each person to use the cms that they had left at the end of the Algebra Chain and Maze competitions to navigate the mazes that they receive. (Do not alter the **Navigation Rules**.)
   c. This still gives an advantage to teams that earned the most cms during the competition, but at least doesn't give them the double benefit of using more cms than other teams to both build a maze and then navigate another's maze.

9. Collect the mazes. Evaluate student work using the MAZE DESIGN RUBRIC before the *Individual Maze Competition* scheduled for the next class.

10. Collect the Team Folders.

11. Prior to the next class make copies of the student mazes for distribution on Day 12. If a student designed a maze that you evaluated as *1 — Incomplete* do not include it in the competition. Randomly choose another maze to photocopy to take its place.

Remind students to draw lines lightly in case they have to move or erase them. When the design is the way they want it, they should draw over their lines to make them darker and more legible.

Day 12

Objectives

- Participate in the *Individual Maze Competition*

Materials

- Student-created mazes — *class set (from previous day)*
- Centimeter rulers — *class set*
- Colored pencils — *class set*
- Scrap paper (small piece) — *class set*

Procedure

1. Direct students to separate their desks and give each a colored pencil, a piece of scrap paper, and a cm ruler. This is an individual, rather than a team activity.

2. Direct students to write a starting number between 1 and 8 on the scrap paper. Once they choose a number they cannot change it.

3. Randomly distribute the mazes making sure that you do not give one team member another team member's (or their own) maze. Do not allow students to turn over their mazes until everyone has one in case you have to switch one before the start.

4. When all students have a maze, tell them to write their name on the maze and circle their starting number.

5. Announce the rules for solving these individual mazes:
   a. Start at the number you chose before seeing this maze.
   b. Use the same number of cms to navigate this individual maze as you used to build your own maze. (See last column of your team **Tally**.)
   c. Use a colored pencil and cm ruler to draw the pathway through the maze. **Maze Rules** on page 3 and **How to Navigate a Maze** on page 8 of the Student Guide apply in this competition, even though students are working independently.
   d. Measure the cms as you draw from the starting point. Keep a running total so that you can see if, or when, you use up all your cms.
   e. If you use up your allotted cms before finishing, mark the place where you ran out with a small X. Then measure how many cms it takes to finish the maze from that point. You will deduct this amount from your team's final total.

TEACHING TIP

You may have to explain the term "running total."

f. If you finish navigating the maze with some cms left over, you will add the leftover cms to your team's total.
g. Record the cms you must deduct or add on the **Tally**. Just add your name under the activity and put the + cms in the **Bonus cms** column or the – cms in the **Cms used** column.
h. Compute the **Cms remaining** column to determine your team's final score.
i. Put your maze in your Team Folder when you are done.

6. After all teams have finished their mazes and computed their final team scores, collect the Team Folders.

7. Before the next class, check the students' work and record keeping. When you are satisfied that the records are accurate, determine the winner of this competition. The team with the highest total cms remaining is the winning team.

You may decide to recognize the winning teams with an award.

Days 13–14

Objectives

- Design, build, and test a marble maze
- **Marble Maze Challenge** (Student Guide, page 7)

Materials

- Team Folders — *one per team*
- MARBLE MAZE PATTERN — *one per team*
- PATTERN FOR BAFFLES — *one per team*
- Centimeter graph paper — *one per team (optional, recommended: for designing Marble Maze Boxes)*
- Centimeter ruler — *one per team*
- Felt pens, crayons, or markers — *enough for students (optional, for decorating Marble Maze Boxes)*
- Marbles — *one per team*
- Oaktag (12" x 18") — *two per team*
- Scissors — *one per team*
- Transparent tape — *one roll per team*

Procedure

1. Distribute Team Folders and direct students to page 7 of the Student Guide, **Marble Maze Challenge**.

2. Read through the directions in the Student Guide and use the following background information to help you answer students' questions.
   a. Students use one sheet of oaktag (12" x 18") to build a rectangular box that is 12 cm x 16 cm x 2 cm. They use the second sheet to make the baffles. When they tape the box closed, no competitor will be able to see inside.
   b. Students then "buy" baffles using the cms that they earned in the Algebra Chain and Maze activities. The baffle designs create strong baffles that will not deform in the box during the competition.
   c. The best design strategy is to tape the baffles in such a way as to create a maze that can only be navigated by tilting the box and allowing the marble to find its way to the "finish" opening. However, students must leave pathways wide enough that a marble will freely roll through.
   d. Each team will experiment with design and modify their box to create a difficult challenge. They must show you the interior maze design before the maze box is taped closed and entered into the competition.

TEACHING TIP

It takes more than one hour for a team of three to design, build, and test a marble maze. Schedule two days or arrange your schedule for a double period.

Take the time to build a box to show as a model. You will be able to give better construction hints, too.

Suggest that students use the cm graph paper to plan out their baffles. Teams can color or decorate their Marble Maze Boxes if there is time.

You can use this opportunity to comment on or evaluate the marble mazes. If a design meets your expectation, it would earn a 3—Expected. However if it is more than you expected—elegant, tricky but fair, and/or is very well constructed then award a 4—Exemplary.

e. Decide how you will determine the amount of cms available for teams to purchase baffles.
   Choice 1: Allot the cms remaining after the last successful maze. (See the last entry posted in the **Cms remaining** column of the team TALLY.)
   Choice 2: Allot the sum of columns 3 and 5 on the TALLY. (**Cms earned + Bonus cms**) for total cms earned
   Choice 3: Allot every team the same number of cms thereby giving each an equal opportunity to build the most difficult box maze.

f. The cost of baffles may need to be adjusted based on the total cms earned by the teams. Regardless which choice you elect, there is only so much room inside the box. By adjusting the baffle price, you limit the number of baffles. Also students can decide not to use all their available cms. The following costs worked well when teams had between 100 and 200 cms available to purchase baffles.

Type / Length of Baffle	Cost / each
• Short, straight (4 cm long)	10 cms
• Long, straight (6 cm long)	15 cms
• "L" shaped (4 cm x 4 cm)	15 cms
• "T" shaped (5 cm x 6 cm)	20 cms

5. When students ask to purchase baffles, ask them to show you that they have enough cms by writing and solving an algebra equation. As they show their accounting, check their algebra. Share the example below, if necessary:
   a. Let A = short straight baffles, B = long straight baffles, L and T = those shaped baffles.
   b. A team wanting 2 short straight, 3 long straight, 4 L shapes and one T shape would write:
      $2A + 3B + 4L + T = n$
      $2(10) + 3(15) + 4(15) + 20 = n$
      $20 + 45 + 60 + 20 = n$
      $145 = n$
   If the team has at least 145 cms, they can purchase what they want. If not, they must eliminate baffle pieces until they achieve an amount they can afford.

6. For some added excitement, allow students to *name* their box maze. Trying to solve the *Wizards' Enigma* sounds more difficult than solving *Team B's Mystery Box.*

TEACHING TIP

If a team is so far behind that they do not have enough cms to purchase any baffles, just give them an amount that allows them to still stay in the competition without displacing other teams who earned the cms.

How well your students completed the Algebra Chains and Mazes will probably determine which choice is best for your class. However, Choice #1 worked best in the piloted classes.

Modify theses costs to fit your classroom situation. For example, increase the cost of each baffle if most teams have more than 200 cms.

*Teams do not use up their **Cms remaining** totals with these purchases. They simply use cms as credits that enable them to get what they want/need.*

7. On the day of the *Marble Maze Challenge*, individual team members from opposing teams try to complete each box maze by moving the marble through the maze to the exit hole in the shortest time. Total team times are added and recorded on the MARBLE MAZE TIME RECORD. The harder the box maze, the longer it takes teams to navigate it. The team whose box accumulates the longest aggregate time is the winner of the challenge competition.
8. Optionally, students may keep track of their individual maze times as they navigate other students' mazes. The student with the lowest total time score can be recognized as the fastest maze solver.
9. Later, the class may want to see what configurations made the mazes difficult. Consider allowing them the opportunity to see all of the designs, revamp their mazes, and repeat the competition.

Day 15

Objectives

- Participate in the *Marble Maze Challenge*
- Take a posttest

Materials

- MARBLE MAZE TIME RECORD — *one per team*
- PRETEST/POSTTEST — *class set*
- Marbles — *one per team*
- Watch/clock with sweep second hand or stop watch — *one per team*

Teacher Reference

- **Pretest/Posttest Key**

Procedure

1. Set up one desk per team along the walls of the room creating the competition space around the perimeter of the room. Allow space between each team desk so that challengers will have the space to manipulate the box, and the team members will have room to time and record the attempt.

2. Direct teams to be certain they have put their team name on the top of the box and put a star by the *Start* hole.

3. Create a rotational pattern for boxes going from team to team. If the desks are arranged around the perimeter of the room, use a clockwise rotation.

4. Limit the time for each challenge to a maximum of two minutes per round.

5. One team member travels with the box in the role of **Timer**. Rotate the Timer role during the competition so that all team members have the opportunity to be a Timer and to experience the mazes created by the other teams.

Divide the number of competing teams by 3 to determine when to rotate the roles. If there are 9 teams, rotate after the 3rd and 6th round.

DAILY DIRECTIONS
DAY 15

TEACHING TIP

Be certain students understand that they must handle the box mazes gently. They may turn and rotate them, but they may never shake or twist them.

Using a wall clock with a sweep second hand works well when timing. Start the competitions when the sweep hand is at the 12.

The Timer can announce the running time in 5 or 10-second intervals to minimize any disagreement about the lapsed time.

If your schedule is flexible, allow students to study the mazes created by others, revamp their designs, and repeat the competition.

6. *Marble Maze Challenge* procedure
   a. The Timer gives the maze and marble to the challenger.
   b. To make sure that all teams start at the same time, the teacher announces the start of the round by saying, "Ready, Set, BEGIN!" and the challengers drop the marbles into the *Start* holes.
   c. When the marble comes out the Exit hole, the challenger says, "Stop."
   d. The Timer states the time and records it on the MARBLE MAZE TIME RECORD.
   e. After two minutes pass, the teacher says, "Stop." If a marble is still in the box maze, that Timer records a two and one-half minute score for that round.
   f. The Timer may need to carefully open the team's box, extract the marble, and re-tape it for the next round.
   g. When all teams have finished recording, the Timers move to the next team to begin a second "two minute" competition.
   h. Continue as time permits, or until all teams have tried each box maze.
   i. Add up the times recorded on the MARBLE MAZE TIME RECORD.

7. The more difficult the box maze, the longer it takes other teams to navigate it. Therefore, the team whose box accumulates the longest aggregate time on the MARBLE MAZE TIME RECORD is the winner of the competition.

8. If there is time, administer the PRETEST/POSTTEST or do so at the next class meeting.

Objectives

- Demonstrate application of *Order of operations*
- Develop speed and confidence when applying the Order of Operations

Materials

- ORDER OF OPERATIONS CHALLENGE — *transparency*
- Dark Crayons — *one per team*
- Scrap paper — *24 sheets per team*

Procedure

1. This is a timed activity. Mask all of the transparency until all teams are ready.

2. This is a team activity and all students should be trying to solve the equations, you will correct only *one* paper per team. Students should rotate the responsibility of who will write the correct answer for each example.

3. Show them the first example and walk through the procedure. Read or tell:

   "a. Look at the numbers and try different ways to solve the problem using the order of operations
   b. When you find the one that works, write the equation in crayon on the scrap paper.
   c. When I say TIME, hold up your paper to show your solution."

4. Reveal only one example at a time. Say START, and begin to time.

5. After 1 minute say TIME! HOLD UP YOUR PAPERS.

6. Walk quickly around the classroom checking the solutions. Award +2 cms or +3 cms for each correct equation.

A quick way to award correct answers is to give a token (poker chip, math manipulative, bean, etc) when a team has a correct equation. At the end, teams turn in their tokens for cms.

EXTENSIONS
WRITING ALGEBRA EQUATIONS

TEACHING TIP

This activity allows students to earn more cms if they need them. You can award +2 cms to +5 cms for each correct answer.

You may run this activity competitively using the same procedure described in the Order of Operations Challenge.

TEACHING TIP

Students should not have access to the WRITING ALGEBRA EQUATIONS handout when they try to solve another team's word problem.

Objectives

- Write and solve algebra equations from statements
- Create algebra word problems from algebra equations (optional)

Materials

- WRITING ALGEBRA EQUATIONS — *one per team*
- Lined paper — *class set*

Procedure

1. Use the instructions on the handout. If students need more instruction, talk them through the example problem. Tell them to work in the space under the example.
   a. First show them that the word "is" means "equals" in these statements. Read or tell:
      "The product of a number and twenty-one <u>is</u> two hundred and thirty-one
      The product of a number and twenty-one = two hundred and thirty-one
   b. Next show them how to replace the words "a number" with one letter that represents an unknown.
      The product of <u>z</u> and twenty-one = two hundred and thirty-one
   c. Next tell them to replace number words with actual numbers.
      The product of z and <u>21</u> = <u>231</u>
   d. Finally show them how to think about the words "product" or "decreased by" or "plus" and the math process implied (x, –, and +)
      z <u>times</u> 21 = 231 or <u>21z</u> = 231
   e. Solve the equation
      z = <u>11</u>."

3. For more of a challenge, use these directions:
   a. Ask students to choose five equations and write a word problem that would match the equation.
   Sample Equation: *<u>The product of a number and twenty-one is two hundred and thirty-one.</u>*
   Sample Word Problem: *21 boxes contain 231 pounds of macaroni. How many pounds of macaroni are in each box?*
   b. Award +5 cms for each problem that earns an *Expected* rating. Award +8 cms for any really clever problems that earn an *Exemplary* rating.
   c. Ask students to choose one of their word problems to challenge another team. Teams recopy the problem and give it to another team who writes the equation and solves it.

Objectives

- Solve more challenging algebra equations
- Solve a three-dimensional maze

Materials

- ALGEBRA CHAIN 6 — *class set*
- MAZE #5 — *one per team + transparency*
- Centimeter ruler — *one per team*
- Colored pencils — *one per team*
- Transparent tape — *one roll per team*

Procedure

1. ALGEBRA CHAIN 6 will allow teams to earn more cms for the MAZE #5 competition. Problems in ALGEBRA CHAIN 6 are more complex than the problems they solved previously.

2. Students will follow the same procedure they did for all chain activities. ALGEBRA CHAIN 6 multiplier value is **3**.

3. MAZE #5 challenges students to visualize the pathway of a three-dimensional maze from a flat, fold-up pattern. Teams must select a starting letter, draw segments, cut out the pattern, fold it, and tape the folded pattern to create a three-dimensional box. They earn additional cms for finishing the fold-up box maze before other teams finish.

4. Display the transparency of MAZE #5 for one minute.

5. In that one minute, teams study the flat pattern of the maze and quietly choose a starting letter, writing it down to commit to a starting point.

6. The team that came in first on ALGEBRA CHAIN 5 claims its starting point (letter) first. If any other team also wants that starting spot they must transfer 5 cms to the first team that claimed that shape and location.

7. When it's their turn, the next three teams may change their starting position by choosing an unoccupied starting point (letter) at no penalty even if they previously committed to a different letter. For example: if the first team chose Y, the second team, initially committed to Y, can shift to another letter. Teams may continue this way until all four letters are claimed. Then the remaining teams who want those starting points must transfer 5 cms to the team that claimed that letter position first.

You may choose to take a moment to have the whole class work on problem #1. Write and solve it on the board before handing out ALGEBRA CHAIN 6.

If you are not using transparencies, distribute MAZE #5 face down. Tell teams to turn it over, quickly discuss it, and choose a starting letter. After one-minute, tell students to turn the maze face down again until you start the race.

8. Team Designers record the positive and negative centimeters on the TALLY.

9. The MAZE #5 activity is a maze *race*, so when all teams are ready, distribute MAZE #5 face down. Start the race by saying, "Turn over your mazes and begin!"
   a. Teams use cms earned on previous algebra chain activities to navigate MAZE #5. (See **Cms remaining** column of team TALLY.)
   b. Members of the team complete the same role responsibilities as they did for all other maze activities.
   c. To figure out the path, they must cut, fold, and temporarily tape the maze, making it into a box.
   d. When they discover the pathway, they should sketch it lightly.
   e. They should then open the maze flat again and with a cm ruler draw and measure the line segments that correctly navigate the maze.
   f. Teams should let the teacher know when they are finished. A team is finished when they have completed three steps:
      Step 1 Draw and label each length of line segments through the maze.
      Step 2 Securely tape the maze into a three-dimensional box.
      Step 3 Complete the TALLY.
   g. Warrant that the teams have accomplished all their tasks, and award teams extra centimeters as they finish. First place gets +10 cms, second place gets +9 cms, third place gets +8 cms, etc.
   h. Note: It is possible that some or all teams may not have enough cms to complete the maze. They should stop when their cms are used up.

Write the requirements for finishing on the chalkboard.

Write the team names in order as they finish. If a team has not completed everything, do not write their name on the board until all the work is done.

Objectives

- Complete several word problem chains
- Describe in writing how to solve algebra word problems (optional)

Materials

- WORD PROBLEM CHAIN A — *class set*
- WORD PROBLEM CHAIN B — *class set*
- WORD PROBLEM CHAIN C — *class set*
- PROBLEM-SOLVING FORMAT SAMPLE — *class set (optional)*
- PROBLEM-SOLVING FORMAT — *three per team (optional)*
- PROBLEM-SOLVING RUBRIC — *class set or as needed*

Teacher Reference

- **Algebra Word Problem Chain A Key**
- **Algebra Word Problem Chain B Key**
- **Algebra Word Problem Chain C Key**

Procedure

1. Cluster students by teams, rotate roles for each challenge, and put a new Recorder in the middle seat for each Algebra Chain. Run as you would any other Algebra Chain. The answer to the first problem is used in the second problem.

2. Distribute WORD PROBLEM CHAIN A. Correct as you would other chains, and add points to each team's TALLY for correct answers and for order of finish. The multiplier for all the word problems is **+5**. Follow the same procedure for WORD PROBLEM CHAINS B and C.

3. For a further challenge, require teams or students working as individuals to describe their problem-solving strategies and math thinking for one of the problems in each chain.
   a. Distribute the PROBLEM-SOLVING FORMAT SAMPLE Working as a whole class, show students how to enter information on the handout.
   b. Although students may be reluctant at first to write down the steps of the process, insist they do so. Do not award cms to teams who have not explained their thinking, even if they determined a correct answer.
   c. Use a 4-point rubric to award points. In order to earn a *3—Expected* or *4—Exemplary,* students must show the equation they designed and the steps they followed to solve it. (See PROBLEM-SOLVING RUBRIC.)
   d. Go over the rubric carefully so that students understand what they must do.
   e. Award additional cms for *Expected* or *Exemplary* work.

How long it will take to complete the chains depends on the skill of your class.

Requiring students to explain their math thinking is a powerful assessment tool. If your schedule allows, don't miss this opportunity. Walk around the class listening to students working in teams or watch as they work individually.

Review the process with other examples, if necessary, until students are confident about how to use the worksheet and what they must do.

A score of 4—Exemplary is worth 40 cms, a score of 3—Expected earns 30 cms, a score of 2 or 1 earns no cms until the problem is reworked and solved/explained adequately.

PRETEST / POSTTEST KEY
TEACHER REFERENCE

1. a = -5

2. b = 33

3. answer = 152

4. answer = 54

5. e = 52

6. f = 66

7. g = 13

8. h = 16

9. j = 176

10. k = 60

11. m = 156

12. n = 151

13. a = number of theater seats
    a = (39 × 13) + (15 × 11)
    a = 507 + 165
    a = 672

14. b = account balance before trip
    b − 84 = 304
    b = 304 + 84
    b = $388

15. c = average savings per CD
    c = (47.85 − 41.85) ÷ 3
    c = 6.00 ÷ 3
    c = $2.00

16. d = cost of 8 batteries
    d = (8 ÷ 2) × 1.89
    d = 4 × 1.89
    d = $7.56

ALGEBRA CHAINS 1 AND 2 KEYS
TEACHER REFERENCE

ALGEBRA CHAIN 1 KEY

1. a = 12
2. b = 12
3. c = 78
4. d = 2
5. e = 11
6. f = 160
7. g = 4920
8. h = 989
9. i = 512
10. j = 121
11. k = 269
12. m = 2
13. n = 224
    final answer

ALGEBRA CHAIN 2 KEY

1. c = 2
2. d = 12
3. e = 3
4. f = 7
5. g = 3
6. h = 6
7. i = 3
8. j = 5
9. k = 13
10. 12
    final answer

INDIVIDUAL ASSESSMENT CHAINS 1–6 KEYS

TEACHER REFERENCE

INDIVIDUAL ASSESSMENT CHAIN 1 KEY

1. 12
2. 300
3. 68
4. 54
5. 3
6. 97

INDIVIDUAL ASSESSMENT CHAIN 2 KEY

1. 34
2. 26
3. 45
4. 90
5. 180
6. 7

INDIVIDUAL ASSESSMENT CHAIN 3 KEY

1. 16
2. 18
3. 7
4. 10
5. 12
6. 11

INDIVIDUAL ASSESSMENT CHAIN 4 KEY

1. 13
2. 21
3. 1
4. 864
5. .5
6. 77.2

INDIVIDUAL ASSESSMENT CHAIN 5 KEY

1. 5
2. 10
3. 14
4. 40
5. 12
6. 21

INDIVIDUAL ASSESSMENT CHAIN 6 KEY

1. 45
2. 1000
3. 640
4. 197
5. 29
6. 20

ALGEBRA CHAINS 3 AND 4 KEYS
TEACHER REFERENCE

ALGEBRA CHAIN 3 KEY

1. a = 34
2. b = 27
3. c = –5
4. d = 8
5. e = 36
6. f = 39.3
7. g = 456.34
8. h = 258.34
9. i = 200
10. j = $65\frac{3}{5}$ or 65.6
11. k = $48\frac{2}{5}$ or 48.4
12. m = $50\frac{1}{5}$ or 50.2
13. n = $20\frac{3}{10}$ or 20.3
    final answer

ALGEBRA CHAIN 4 KEY

1. a = 18
2. b = 6
3. c = 12
4. d = 11
5. e = 44
6. f = 2
7. g = 1
8. h = 3
9. i = 9
10. j = 72
11. k = 864
12. m = 432
13. n = 108
    final answer

ADDITIONAL PROBLEMS MAZE #4 KEY

TEACHER REFERENCE

1. n = 18
2. n = 12
3. n = 5
4. n = 5
5. n = 2
6. n = 121
7. n = 14
8. n = 3
9. n = 6
10. n = 1
11. n = 2
12. n = 15
13. n = 19
14. n = 36
15. n = 3
16. n = 1
17. n = 256
18. n = 18
19. n = 23
20. n = 11

ALGEBRA CHAINS 5 AND 6 KEYS
TEACHER REFERENCE

ALGEBRA CHAIN 5 KEY

1. a = 80
2. b = 40
3. c = 32
4. d = 48
5. e = 384
6. f = 40
7. g = 24
8. h = 62.4
9. i = 4
10. j = 48
11. k = 200
12. m = 500
13. n = 2500
    final answer

ALGEBRA CHAIN 6 KEY

1. a = 167
2. b = 64
3. c = 40
4. d = 5
5. e = 1000
6. f = 37
7. g = 63
8. h = 147
9. i = 1
10. j = 10
11. k = 27
12. m = 42
13. n = 28
    final answer

EXTENSIONS KEYS
TEACHER REFERENCE

ORDER OF OPERATIONS CHALLENGE KEY

1. $5 + 3 + 2 = 10$
2. $(5 + 3) \times 2 = 16$
3. $5 \times 3 \div 2 = 7.5$
4. $5 + 3 - 2 = 6$
5. $5 \times 3 + 2 = 17$
6. $(5 + 3) \div 2 = 4$ or $5 - 3 + 2 = 4$ or $(5 - 2) + 2 = 4$
7. $5 \times 3 - 2 = 13$
8. $5 \times 3 \times 2 = 30$
9. $5 - 3 \times 2 = -1$
10. $5 \div 3 + 2 = 3\frac{2}{3}$
11. $5 \div 3 - 2 = -\frac{1}{3}$
12. $(5 - 3) \div 2 = 1$ or $5 \div (3 + 2) = 1$
13. $7 \times 6 + 3 = 45$
14. $7 \times (6 \div 3) = 14$ or $(7 \times 6) \div 3 = 14$
15. $7 \times 6 \times 3 = 126$
16. $7 + 6 + 3 = 16$
17. $7 - (6 - 3) = 4$
18. $7 + (6 - 3) = 10$
19. $7 - (6 + 3) = -2$
20. $(7 + 6) \times 3 = 39$ or $7 \times 6 - 3 = 39$
21. $(7 + 6) \div 3 = 4\frac{1}{3}$
22. $7 \div (6 \div 3) = 3\frac{1}{2}$
23. $(7 - 6) \div 3 = \frac{1}{3}$
24. $(7 - 6) \times 3 = 3$
25. $7 \div (6 \times 3) = \frac{7}{18}$ or $7 \div 6 \div 3 = \frac{7}{18}$
26. $7 \div 6 - 3 = -1\frac{5}{6}$
27. $7 \div 6 + 3 = 4\frac{1}{6}$

WRITING ALGEBRA EQUATIONS KEY

1. $z = 11$
2. $z = 9$
3. $z = 13$
4. $z = 120$
5. $z = 65$
6. $z = 15$
7. $z = 100$
8. $z = 20$
9. $z = 8$
10. $z = 25$

EXTENSIONS KEYS
TEACHER REFERENCE

WORD PROBLEM CHAIN A KEY

1. a = miles per gallon
   a = 336 ÷ (15 ÷ 1.25)
   a = 336 ÷ 12
   a = 28

2. b = gallons to buy
   $b = (\frac{4}{4} - \frac{1}{4}) \times 28$
   $b = \frac{3}{4} \times 28$
   or
   $b = (28 \times \frac{1}{4}) \times 3$
   b = 7 × 3
   b = 21

3. c = cost of down payment
   c = (21 x 30) × .2
   c = 630 × .2
   c = $126

4. d = earnings for one year
   d = (12 ÷ 4) × 126
   d = 3 × 126
   d = $378

5. e = total cost of 8 bikes
   e = (8 × 378) + (8 × 378 × .06)
   e = 3024 + 181.44
   or
   e = (8 × 378 × 1.06)
   e = $3205.44

WORD PROBLEM CHAIN B KEY

1. a = cost of other 3 items
   a + 15 = 119
   a = 119 – 15
   a = $104

2. b = prior account balance
   b – 104 = 484
   b = 484 + 104
   b = 588

3. c = card count before sale
   c – 588 = 303
   c = 303 + 588
   c = 891

4. d = final test points
   891 + d = 980
   d = 980 – 891
   d = 89

5. e = amount saved
   89 + e = 1500
   e = 1500 – 89
   e = 1411

WORD PROBLEM CHAIN C KEY

1. a = amount owed
   4a = 68
   a = 68 ÷ 4
   a = 17

2. b = miles per student
   17 × .75 × b = 318.75
   12.75 × b = 318.75
   b = 318.75 ÷ 12.75
   b = 25

3. c = original price
   c × 80%= 25
   c = 25 ÷ 80%
   c = 25 ÷ .8
   c = $31.25

4. d = hourly rate
   (31.25 – 10.25) x d = 189
   21 × d = 189
   d = 189 ÷ 21
   d = $9

5. e = hourly rate
   3 × 9 × e = 405
   27 × e = 405
   e = 405 ÷ 27
   e = $15

Name _____

COOPERATIVE GROUP WORK RUBRIC

4—EXEMPLARY

You *consistently* and *actively* helped your group achieve its goals by communicating well with other group members, by encouraging the group to work together, and by *willingly* accepting and completing the necessary work of your daily role.

3—EXPECTED

You *usually* helped your group achieve its goals by communicating with other group members, by encouraging your group to work together, and by accepting and completing the necessary work of your daily role.

(If your evaluation is less than EXPECTED,
try to use your cooperating skills more consistently.)

2—You *sometimes* helped your group achieve its goals.

1—You *did very little* to help your group achieve its goals.

Name _____

COOPERATIVE GROUP WORK RUBRIC

4—EXEMPLARY

You *consistently* and *actively* helped your group achieve its goals by communicating well with other group members, by encouraging the group to work together, and by *willingly* accepting and completing the necessary work of your daily role.

3—EXPECTED

You *usually* helped your group achieve its goals by communicating with other group members, by encouraging your group to work together, and by accepting and completing the necessary work of your daily role.

(If your evaluation is less than EXPECTED,
try to use your cooperating skills more consistently.)

2—You *sometimes* helped your group achieve its goals.

1—You *did very little* to help your group achieve its goals.

TALLY

Team _____

Activity	Score	Multiplier (x)	Cms earned	Transfer (+ or –)	Bonus cms	Total cms	Cms used	Cms remaining

PRETEST / POSTTEST (1)

Directions: Solve these equations. For some you must find the unknown variable; for others use the value give for the variable to solve the problem.

1. $7 \times 6 \div (14 - 8) = a$ — a = ☐

2. $b + 73 \times 3 - 17 = 235$ — b = ☐

3. $5c + 6c - 3c =$
 $c = 19$ — answer = ☐

4. $32d \div 8 + 2d =$
 $d = 9$ — answer = ☐

5. $e - 21 = 31$ — e = ☐

6. $f + 12 = 6(8 + 5)$ — f = ☐

7. $7g = 91$ — g = ☐

8. $20h = (9 \times 40) - 40$ — h = ☐

9. $\frac{1}{4}j = 44$ — j = ☐

10. $.5k = 30$ — k = ☐

11. $(29 - 11) - 9 = 1404 \div m$ — m = ☐

12. $141 + 235 - (4^3 \times 3) = n + 33$ — n = ☐

PRETEST / POSTTEST (2)

Directions: Write a proper algebraic equation and then solve for the variable.

13. Your school is attending a play at a theater. There are 39 rows with 13 seats in each row. There is also a balcony that has 15 rows with 11 seats in each row. How many students can the theater seat?

14. Your club spent $84 on a trip to visit the local art museum. There was only $304 left in the club's bank account after the trip was paid for. How much did the club have before the trip?

15. Marcus bought 3 CDs on sale. The original cost was $47.85, but Marcus only paid $41.85 because of the sale. On average, how much did Marcus save on each CD?

16. Camera batteries cost 2 for $1.89. How much will 8 batteries cost?

ALGEBRA CHAIN 1
ORDER OF OPERATIONS

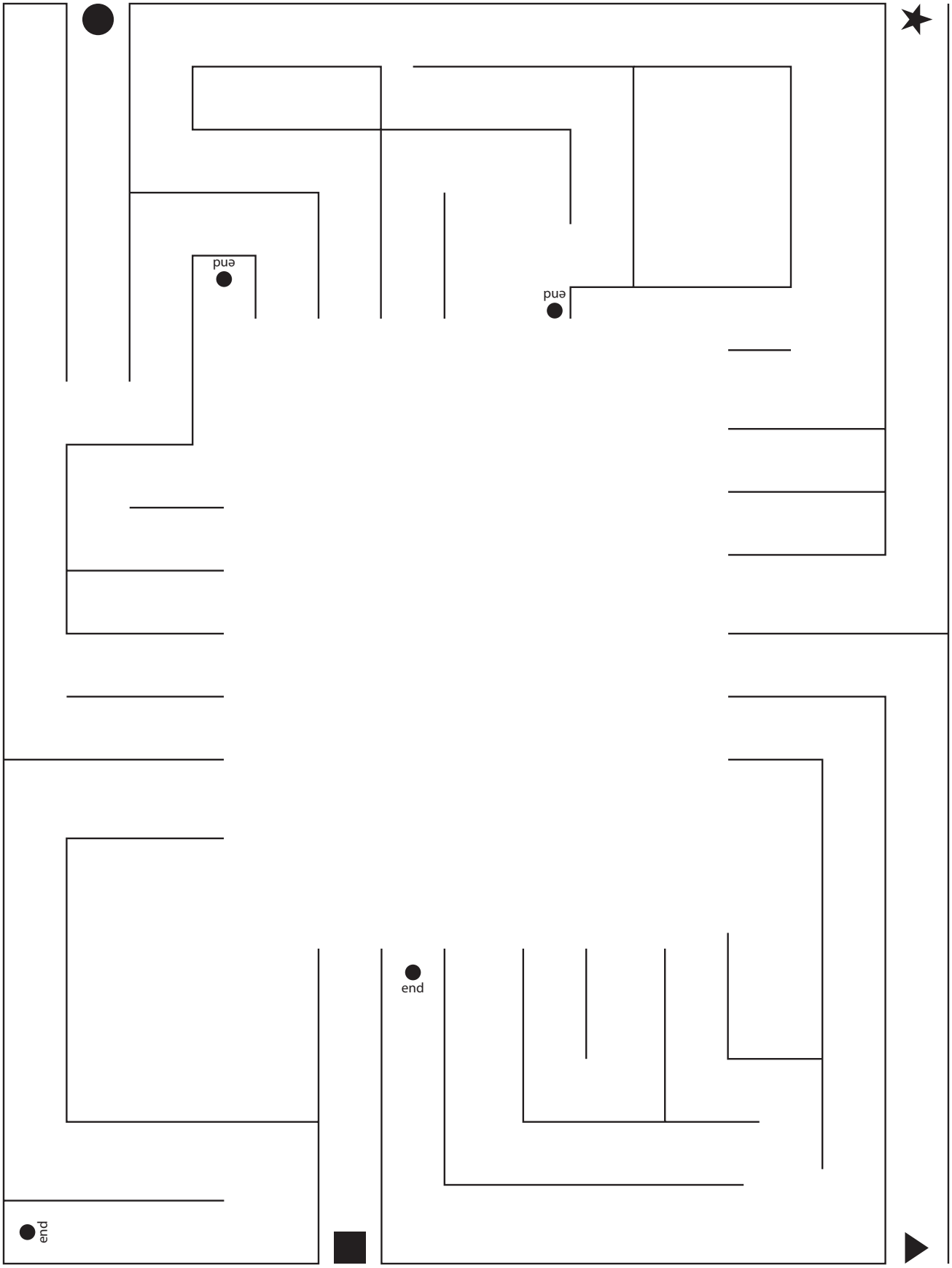
Directions

1. Your teacher will give the value of the first unknown, z.
2. Use that value in the equation in problem #1 to find the next unknown, a.
3. Use *that* value in the equation in problem #2 to find the next unknown, b.
4. Each problem may be solved following order of operations procedures.

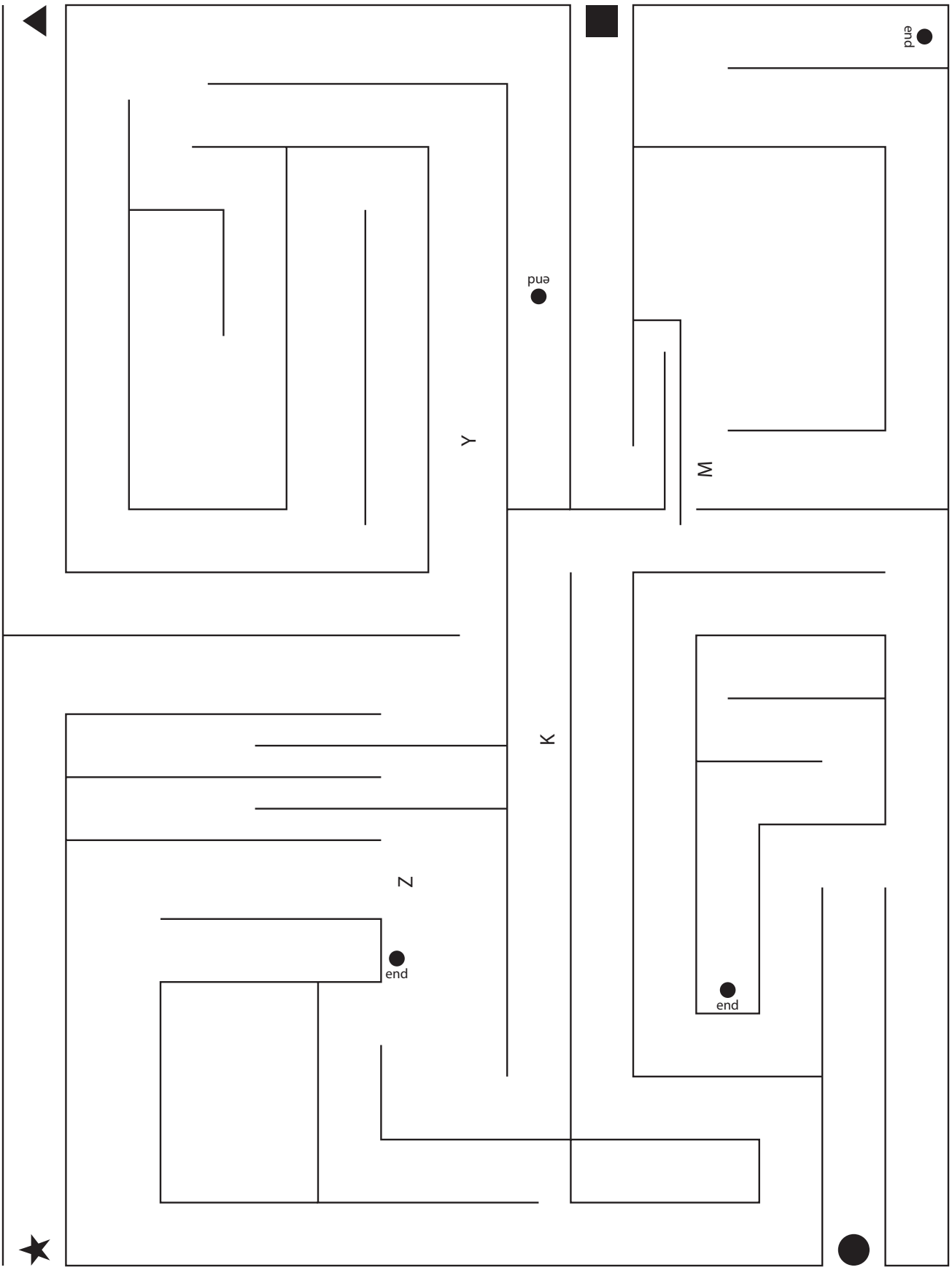
z =

1. $[(z \times 8) \div (4 \div 2)] =$ a =
2. $(6 \times 6) \div (15 - a) =$ b =
3. $[(30 \times 10) + b] \div 4 =$ c =
4. $[c \div (351 \div 9)] =$ d =
5. $[(36 \div d) - (42 \div 6)] =$ e =
6. $[e + (77 \times 2)] - 5 =$ f =
7. $(f \div 4) \times [(10 \times 10) + 23] =$ g =
8. $[(g + 38) - 13] \div 5 =$ h =
9. $[(h + 38) - 3] \div 2 =$ i =
10. $(i \div 4) - (42 \div 6) =$ j =
11. $(j \times 3) - (100 - 6) =$ k =
12. $[(k \times 2) - (25 \times 20)] \div 19 =$ m =
13. $[(48 \times m) \div 3] \times 7 =$ n = final answer

PARTIAL MAZE #1



MAZE #1



ALGEBRA CHAIN 2

SUBSTITUTION OF A NUMERICAL VALUE FOR A VARIABLE

Directions

1. Your teacher will give the value of the first unknown, b.
2. Use that value in the equation in problem #1 to find the next unknown, c.
3. Use *that* value in the equation in problem #2 to find the next unknown, d.
4. Each problem may be solved by substitution of a value for the unknown in that problem.

b = ☐

1. $(4b + 19 + 3) \div 17 =$ c = ☐
2. $5c + 4c - 3c =$ d = ☐
3. $(4d \div 8) + 5d - 63 =$ e = ☐
4. $6e - 5e + 19 - 5e =$ f = ☐
5. $(24f \div 42) + f - 8 =$ g = ☐
6. $2g + 11d + 19c - 170 =$ h = ☐
7. $[(6h \div 3g) + 7f - 2] \div 17 =$ i = ☐
8. $[(3e + 3g - 3i) + 3f] \div h =$ j = ☐
9. $(b + 2c + 3d + 4f) - (5g + 4h + 3i + 2j) =$ k = ☐
10. $(kg + fe) \div j =$ ☐ final answer

Individual Assessment Chain 1

Order of operations

Name _____ **Team** _____

Directions: Solve these equations using the Order of Operations.

1. $[(3 \times 8) \div (4 \div 2)] =$ ☐
2. $(20 \div 2) \times (15 \times 2) =$ ☐
3. $4 \times [(8 + 9) \div (14 - 13)] =$ ☐
4. $51 - 1 + 12 \div 3 =$ ☐
5. $115 \div 5 - 40 \div 2 =$ ☐
6. $4 \times 8 + 9 \times 7 - 9 \times 6 + 8 \times 7 =$ ☐

Individual Assessment Chain 2

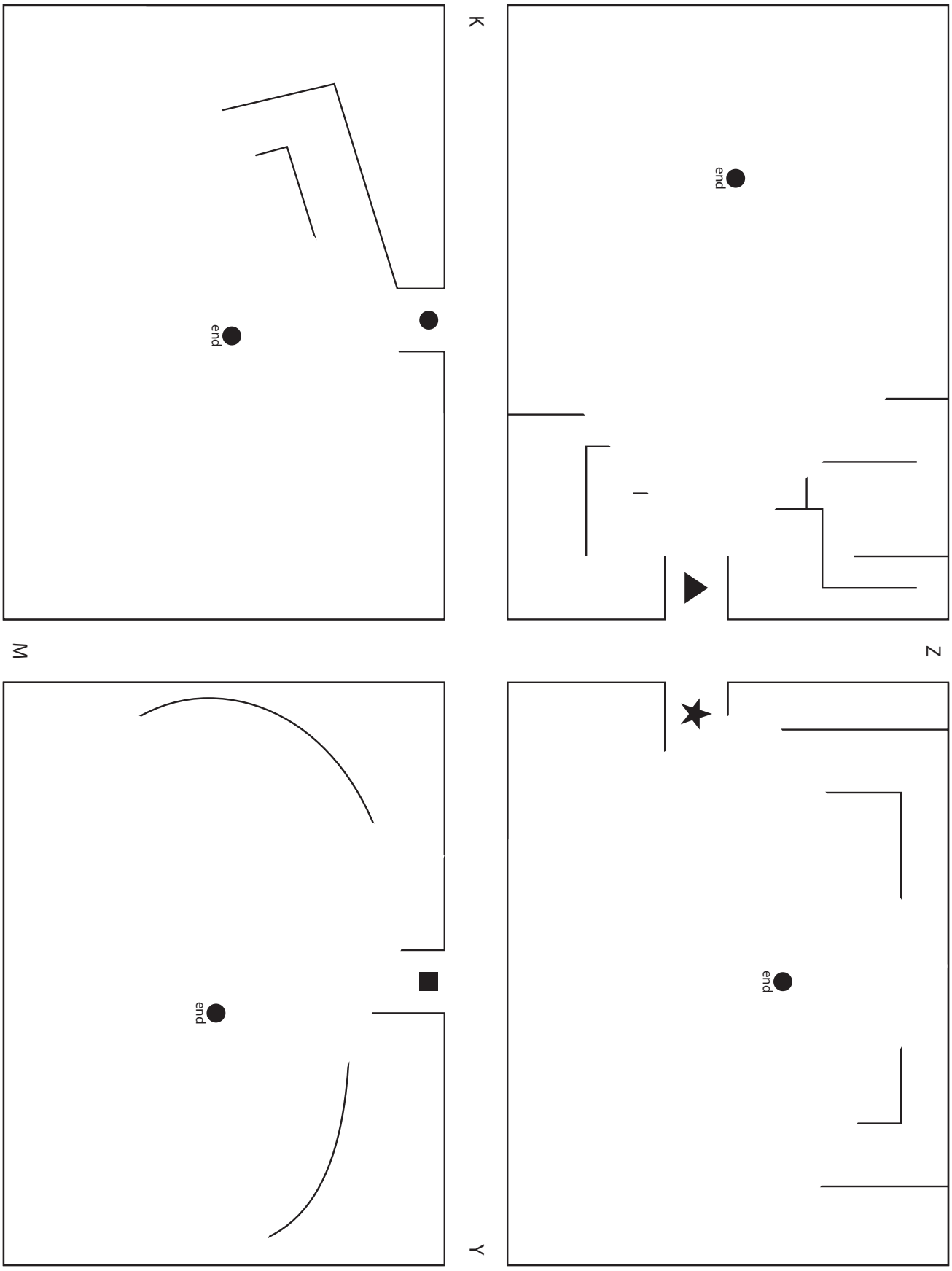
Substitution of a numerical value for a variable

Name _____ **Team** _____

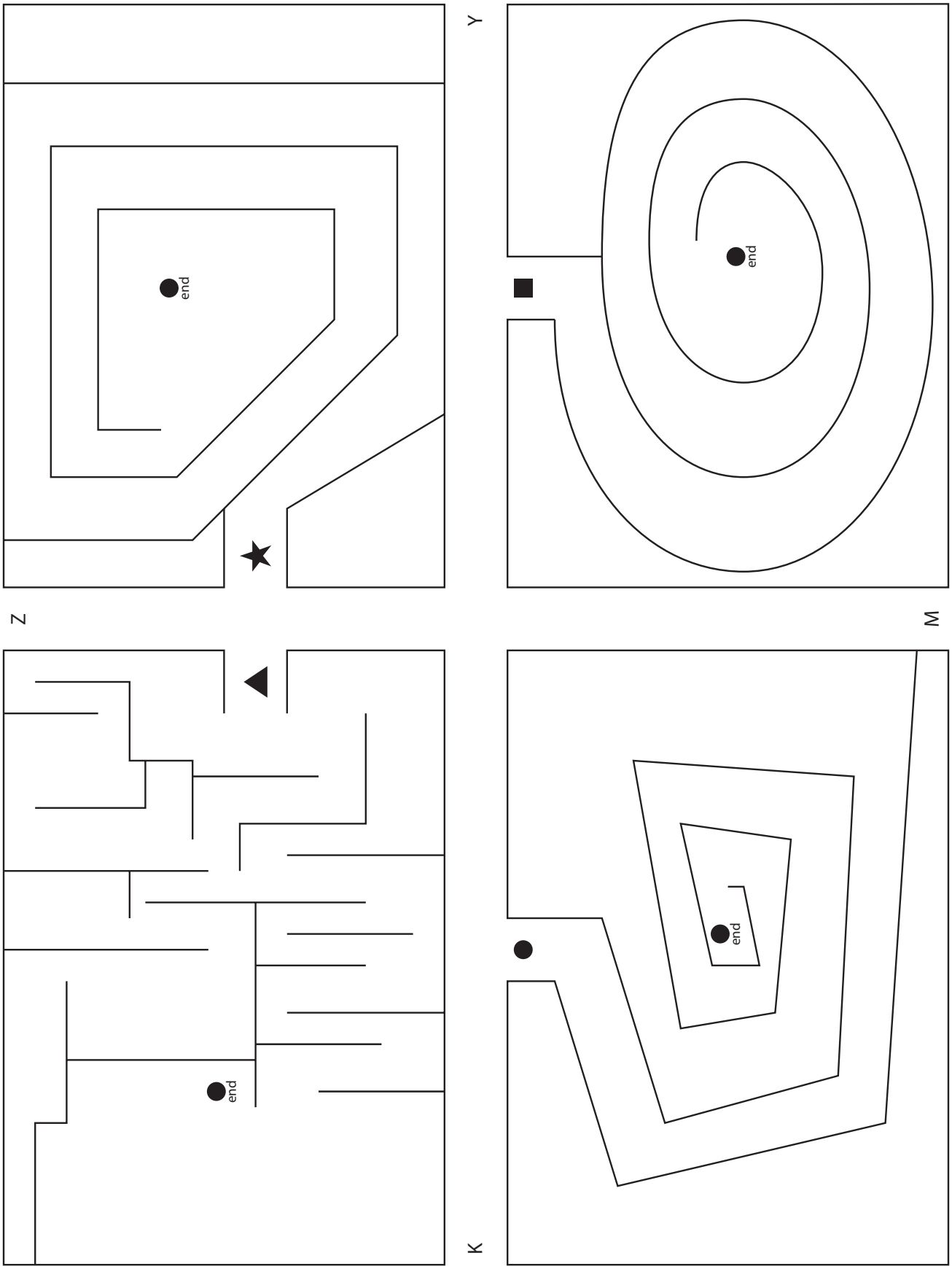
Directions: Complete these problems solving for "a" when a = 18.

1. $a + 16 =$ ☐
2. $(29 - a) + (a - 3) =$ ☐
3. $(a + 9) + (a + 18) - a =$ ☐
4. $5a =$ ☐
5. $6a + 4a =$ ☐
6. $(7a - 16) - [(2a + 5a) - 23] =$ ☐

PARTIAL MAZE #2



MAZE #2



PEER AUDIT REPORT

Directions

1. **Audit** (Evaluate) the work of another team.
   a. Measurer—re-measure the line segments on the **Maze**.
   b. Recorder—check the total cms used for navigating the **Maze**.
   c. Designer—checks all **Tally** entries.
   d. Receive +5 cms for finding a mistake on the **Maze** or **Tally**.
2. Prepare a **Peer Audit Report**.
   a. If the records are without errors, certify by signing below. The audited team earns +5 cms for each **Maze** or **Tally**.
   b. If you find one or more errors, document the finding below. Write the location of the error (either ***Maze*** or ***Tally***). Write a short description (such as *Third Line segment is 3.7 cms, not 2.7cms*.)
3. **Audit Procedures**
   a. Allow line segment measurements that are within ±0.3 cm.
   b. The totals recorded on the **Tally** should be accurate.
   c. Any finding of error must be confirmed by another team or your teacher.
   d. If the audited team disagrees with your evaluation, see your teacher.
   e. If your error finding is rejected, you must transfer +5 cms to the team you were auditing.

Certification of Accurate Records

We hereby certify that the **Maze** and **Tally** of Team _____ are accurate. This team is eligible to earn +5 cms for an accurate **Maze** and +5 cms for an accurate **Tally**.

Signed _____ Recorder for Team _____

Finding of Error

We found the following error(s) in the **Maze** or **Tally** of Team _____ . This team will be penalized –5 cms for each error. Our team is eligible for an additional +5 cms for finding errors.

Location of error	Description of Error	Confirmed	Rejected

Signed _____ Recorder for Team _____

ALGEBRA CHAIN 3
TRANSFORMATIONS: ADDITION AND SUBTRACTION

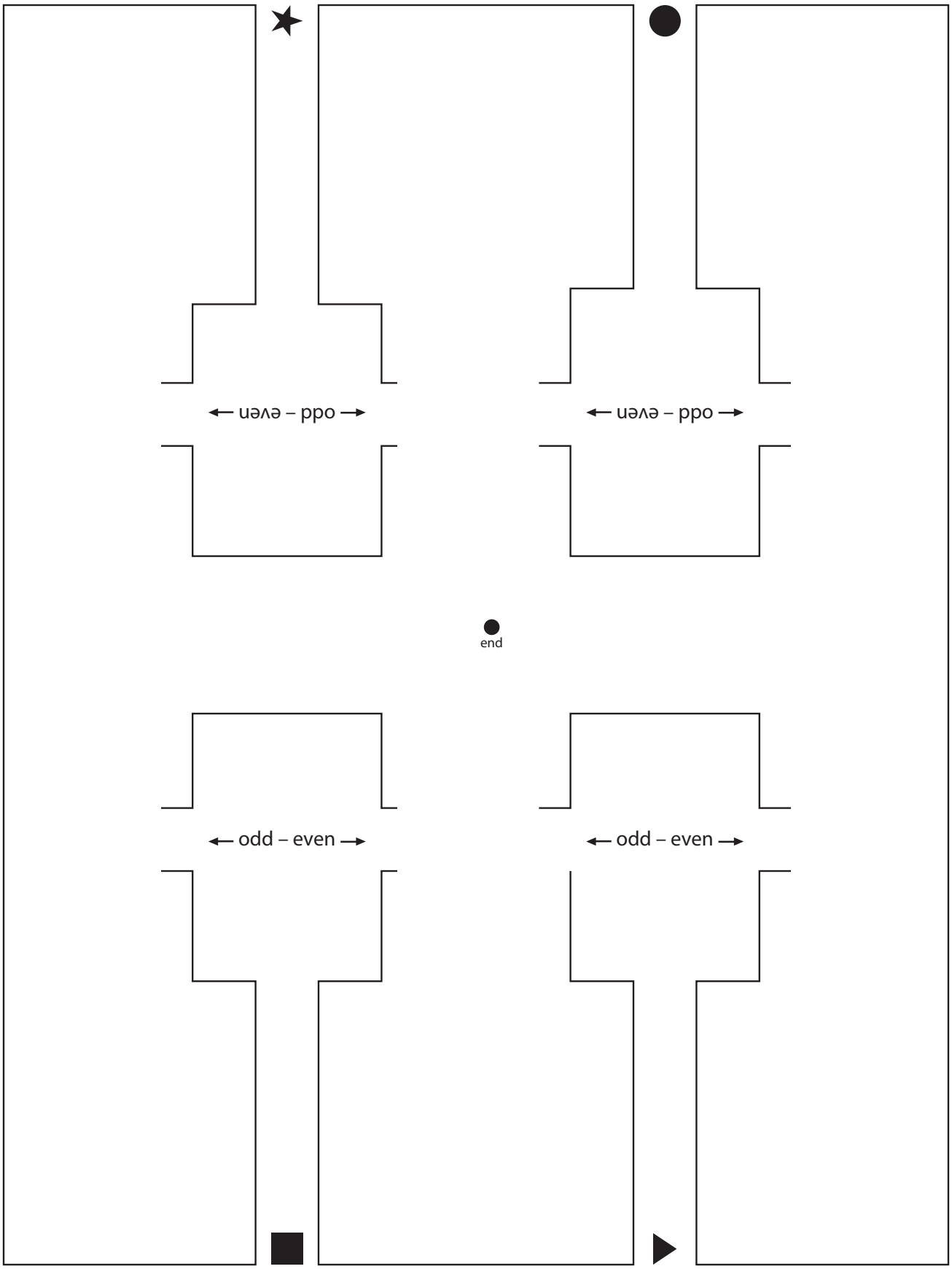
Directions

1. Your teacher will give the value of the first unknown, z.
2. Use that value in the equation to find the next unknown, a.
3. Use *that* value in the equation to find the next unknown, b.
4. Solve the transformation and use each new answer to get you started on solving the next problem by placing that answer in the next box.

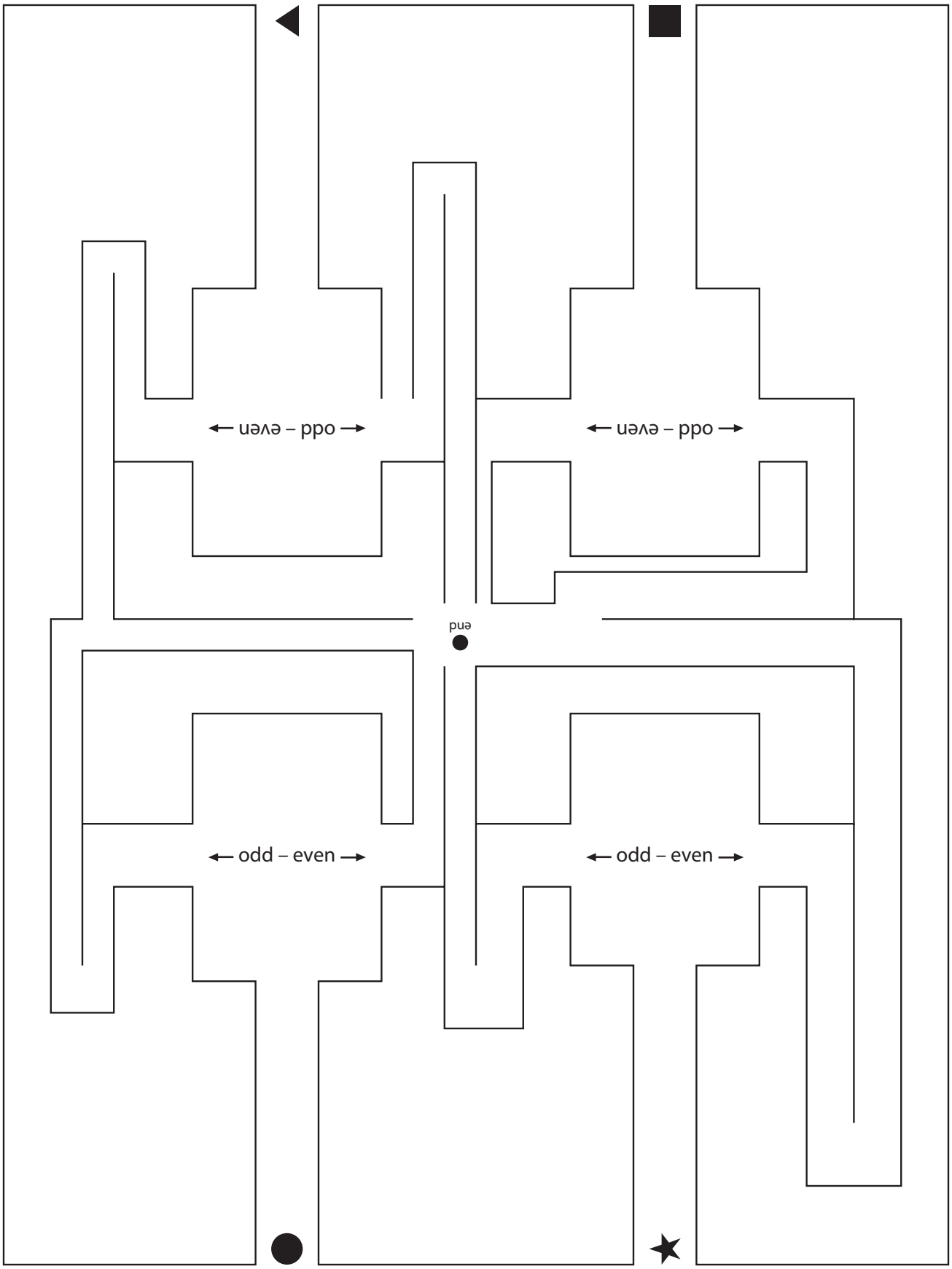
z = ☐ Place this value in the box in equation 1.

1. a − ☐ = 25 a = ☐
2. b − ☐ = − 7 b = ☐
3. ☐ + (− 32) = c c = ☐ −
4. d = − ☐ + 13 d = ☐
5. e + ☐ = 4(9 + 2) e = ☐
6. f − ☐ = 3.3 f = ☐
7. g − ☐ = 417.04 g = ☐
8. ☐ − h = 198 h = ☐
9. ☐ − 58.34 = i i = ☐
10. ☐ = $134\frac{2}{5}$ + j j = ☐
11. ☐ − k = $17\frac{1}{5}$ k = ☐
12. ☐ − m = $-1\frac{4}{5}$ m = ☐
13. ☐ = $70\frac{1}{2}$ − n n = ☐ final answer

PARTIAL MAZE #3



MAZE #3



ALGEBRA CHAIN 4
TRANSFORMATIONS: MULTIPLICATION AND DIVISION

Directions

1. Your teacher will give the value of the first unknown, z.
2. Use that value in the equation to find the next unknown.
3. Solve the transformation and use each new answer to get you started on solving the next problem by placing that answer in the next box.

z = ☐ Place this value in the box in equation 1.

1. 4a = ☐ a = ☐
2. 3b = ☐ b = ☐
3. ☐ c = 72 c = ☐
4. ☐ d = 132 d = ☐
5. $\frac{e}{4}$ = ☐ e = ☐
6. $\frac{\square}{f}$ = 22 f = ☐
7. $\frac{\square}{g}$ = 9 – 7 g = ☐
8. 17h = 52 – ☐ h = ☐
9. 24i = ☐ x 72 i = ☐
10. $\frac{j}{8}$ = ☐ j = ☐
11. $\frac{k}{12}$ = ☐ k = ☐
12. 2m = ☐ m = ☐
13. ☐ = 4n n = ☐ final answer

Individual Assessment Chain 3

Transformations involving addition and subtraction

Name _____ **Team** _____

Directions: Complete these problems.

1. $a + 17 = 33$ $a =$ ☐
2. $b - 17 + b = 19$ $b =$ ☐
3. $3c + 24 = 45$ $c =$ ☐
4. $4d - 2d + 8 = 28$ $d =$ ☐
5. $5e + (19 - 7) = 72$ $e =$ ☐
6. $9f + 18 - f = 106$ $f =$ ☐

Individual Assessment Chain 4

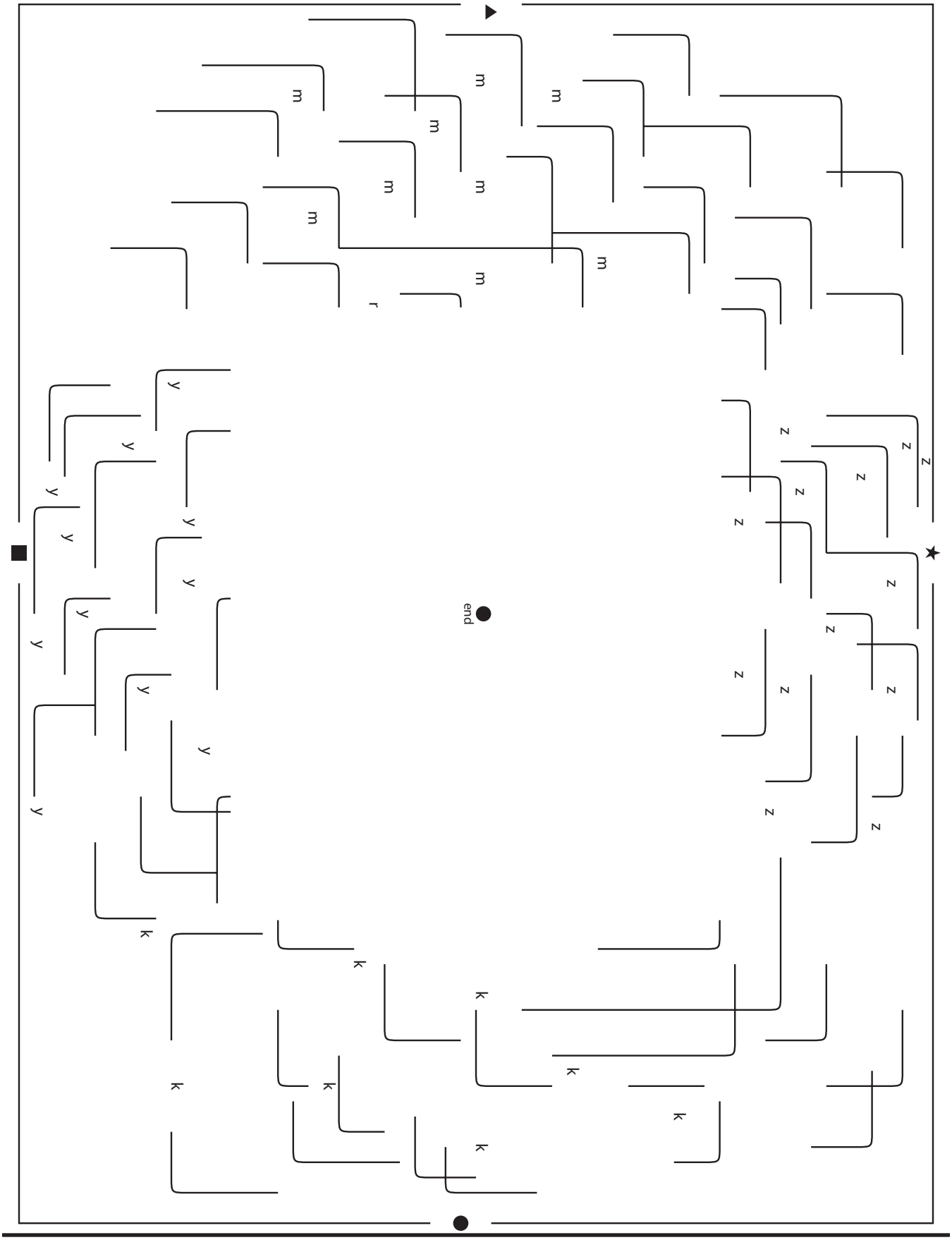
Transformations involving multiplication and division

Name _____ **Team** _____

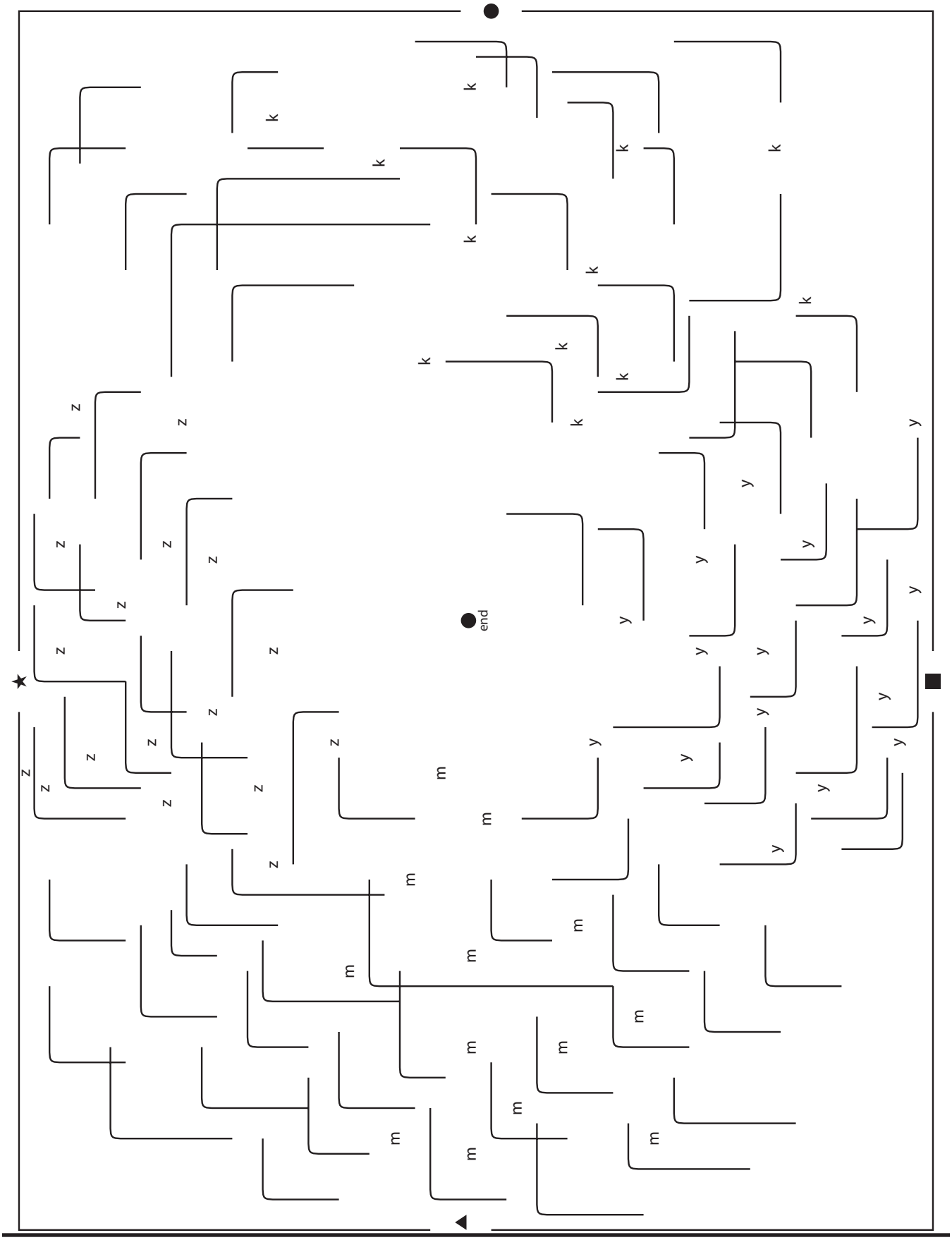
Directions: Complete these problems.

1. $7a = 91$ $a =$ ☐
2. $9b - 3 = 190 - 4$ $b =$ ☐
3. $\frac{2}{c} = 9 - 7$ $c =$ ☐
4. $\frac{h}{12} = 72$ $h =$ ☐
5. $108m = 54$ $m =$ ☐
6. $.5 = \frac{38.6}{n}$ $n =$ ☐

PARTIAL MAZE #4



MAZE #4



ADDITIONAL PROBLEMS MAZE #4

1. $3n + 5n = 144$ n =
2. $12n - 4n + 12 = 108$ n =
3. $8n + n - 3n + 7 = 37$ n =
4. $15n - 3n - 18 = 42$ n =
5. $27n + n - 3n + 20 = 70$ n =
6. $\frac{5}{11}n - 24 = 31$ n =
7. $18n + 12n = 420$ n =
8. $19n - 9n + n - 11 = 22$ n =
9. $5n + 2(n + 3) = 48$ n =
10. $3 + 2(3n + 1) + 4n = 15$ n =
11. $17(n + 3) + 8n = 101$ n =
12. $n + 7n - 18 = 102$ n =
13. $3(n + 2) + 7n = 196$ n =
14. $\frac{2}{9}n + 12 = 20$ n =
15. $3 + 5(n + 6) = 48$ n =
16. $3(7n + 6) = 2(19) + 1$ n =
17. $\frac{n}{16} \div 16 = (17 - 15) \div 2$ n =
18. $24n + 3n - 20n = 126$ n =
19. $12(3n + 1) + 4n = 932$ n =
20. $29n - 6n = 253$ n =

ALGEBRA CHAIN 5
USING RECIPROCALS WITH FRACTIONS AND DECIMALS

Directions

1. Your teacher will give the value of the first unknown, z.
2. Use that value in the equation to find the next unknown.
3. Solve the transformation and use each new answer to get you started on solving the next problem by placing that answer in the next box.

z = ☐ Place this value in the box in equation 1.

1. .4a = ☐ a = ☐
2. $\frac{b}{.5}$ = ☐ b = ☐
3. $\frac{5}{4}$c = ☐ c = ☐
4. $\frac{d}{1.5}$ = ☐ d = ☐
5. $\frac{1}{8}$e = ☐ e = ☐
6. $\frac{\square}{f}$ = 9.6 f = ☐
7. 1.75g = ☐ + 2 g = ☐
8. $\frac{h}{2.6}$ = ☐ h = ☐
9. ☐ i = 249.6 i = ☐
10. $\frac{1}{12}$j = ☐ j = ☐
11. .24k = ☐ k = ☐
12. .4m = ☐ m = ☐
13. ☐ = .2n n = ☐ final answer

INDIVIDUAL ASSESSMENTS CHAINS 5 AND 6

Individual Assessment Chain 5
Using reciprocals to solve algebraic equations containing fractions and decimals

Name _____ **Team** _____

Directions: Solve these equations.

1. $\frac{150}{a} = 30$ a =
2. $\frac{2n}{5} + 6 = 10$ n =
3. $\frac{5 + 2x}{3} = 11$ x =
4. $14 = \frac{b}{2} - 6$ b =
5. $\frac{3s - 4}{8} = 4$ s =
6. $\frac{n + 12}{3} = 11$ n =

Individual Assessment Chain 6
Complex problems

Name _____ **Team** _____

Directions: Solve these equations.

1. $n - (50 \div 10) = 760 \div 19$ n =
2. $b - 5\ [18(900 \div 90)] = 100$ b =
3. $\frac{c + (6^2)\ (2^2) + 16}{2^5} = 5^2$ c =
4. $d + 16^2 = (7^3 \times 3) - (8 \times 3)^2$ d =
5. $e + 5(16 \div 8) = 351 \div 9$ e =
6. $(5^2 - 2^4)2 + 5 = 3 + k$ k =

DESIGNING INDIVIDUAL MAZES

Your goal is to create the most challenging maze possible. You want to require the person attempting to navigate your maze to use the maximum cms possible.

Design Rules

1. Design your maze on the **Individual Maze Template**.
2. Consult the **Cms remaining** column of your team **Tally**.
3. Use that number of cms to build the walls of your maze.
   (For example, if your team has 100 in the **Cms remaining** column, all three members of your team may use 100 cms each when designing your mazes.)
4. Measure and label all inside walls of your maze. Compute the total length of all the walls to be certain that you do not exceed the total cms available.
5. Write your name and team name on the back of the maze when you finish.

Maze Design Rubric

4—EXEMPLARY — Final maze is neatly and accurately drawn and exceeds expectations. All walls are measured and labeled. The maze design offers an opponent a fair chance of success while using the maze template appropriately.

3—EXPECTED — Final maze is drawn acceptably and meets expectations. The maze is complete and walls are measured and labeled. The design is fair and uses the maze template appropriately.

2—NEARLY THERE — Final maze is complete, but difficult to read. Lines are difficult to see and labels are incomplete and/or incorrect. The design appears unfair and/or does not use the template correctly. Meet with the teacher as soon possible to make a plan of action to correct the maze.

1—INCOMPLETE — Final maze is incomplete and unlabeled. The maze is unusable and/or does not use the template. Meet with the teacher as soon possible to make a plan of action to create a new maze.

Navigating Individual Mazes

Your goal is to navigate another student's maze in the most efficient manner possible. You want to use the minimum number of cms to navigate.

Navigation Rules

1. Consult the **Cms remaining** column of your team **Tally**.
2. This is the number of **cms available** for you to use to navigate the maze.
   (For example, if your team has 100 in the **Cms remaining** column, each team member may use 100 cms to navigate the maze.)
3. Measure your path carefully. Keep a running total of the cms you use as you navigate the maze.
4. If you use up all **cms available** before you reach the end of the maze, you must charge any additional cms against your team's total in the **Cms remaining** column. This will lower your team's final cms total.
5. Subtract the number of cms used navigating the maze from the **cms available** before you began navigating. The result may be a negative number.
6. All team members combine their remaining unused cms, either adding those remaining, or subtracting those borrowed against the **cms available** beginning total. The team with the most **Cms remaining** on the team **Tally** is the winning team.

INDIVIDUAL MAZE TEMPLATE

1 2 3 4 5 6 7 8

Name _____

MAZE DESIGN RUBRIC

4—EXEMPLARY — Final maze is neatly and accurately drawn and exceeds expectations. All walls are measured and labeled. The maze design offers an opponent a fair chance of success while using the maze template appropriately.

3—EXPECTED — Final maze is drawn acceptably and meets expectations. The maze is complete and walls are measured and labeled. The design is fair and uses the maze template appropriately.

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1—INCOMPLETE — Final maze is incomplete and unlabeled. The maze is unusable and/or does not use the template. Meet with the teacher as soon possible to make a plan of action to create a new maze.

Name _____

MAZE DESIGN RUBRIC

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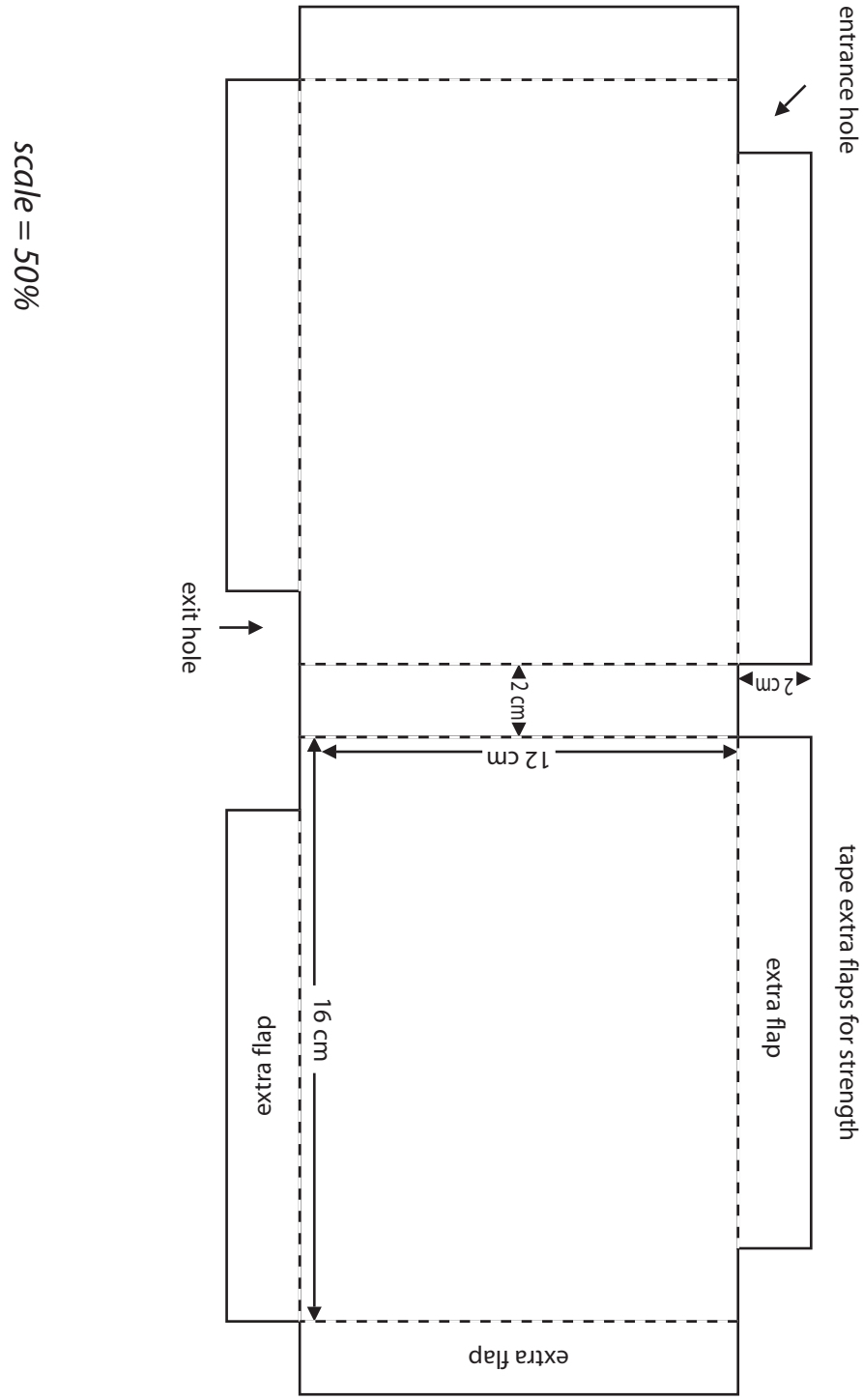
3—EXPECTED — Final maze is drawn acceptably and meets expectations. The maze is complete and walls are measured and labeled. The design is fair and uses the maze template appropriately.

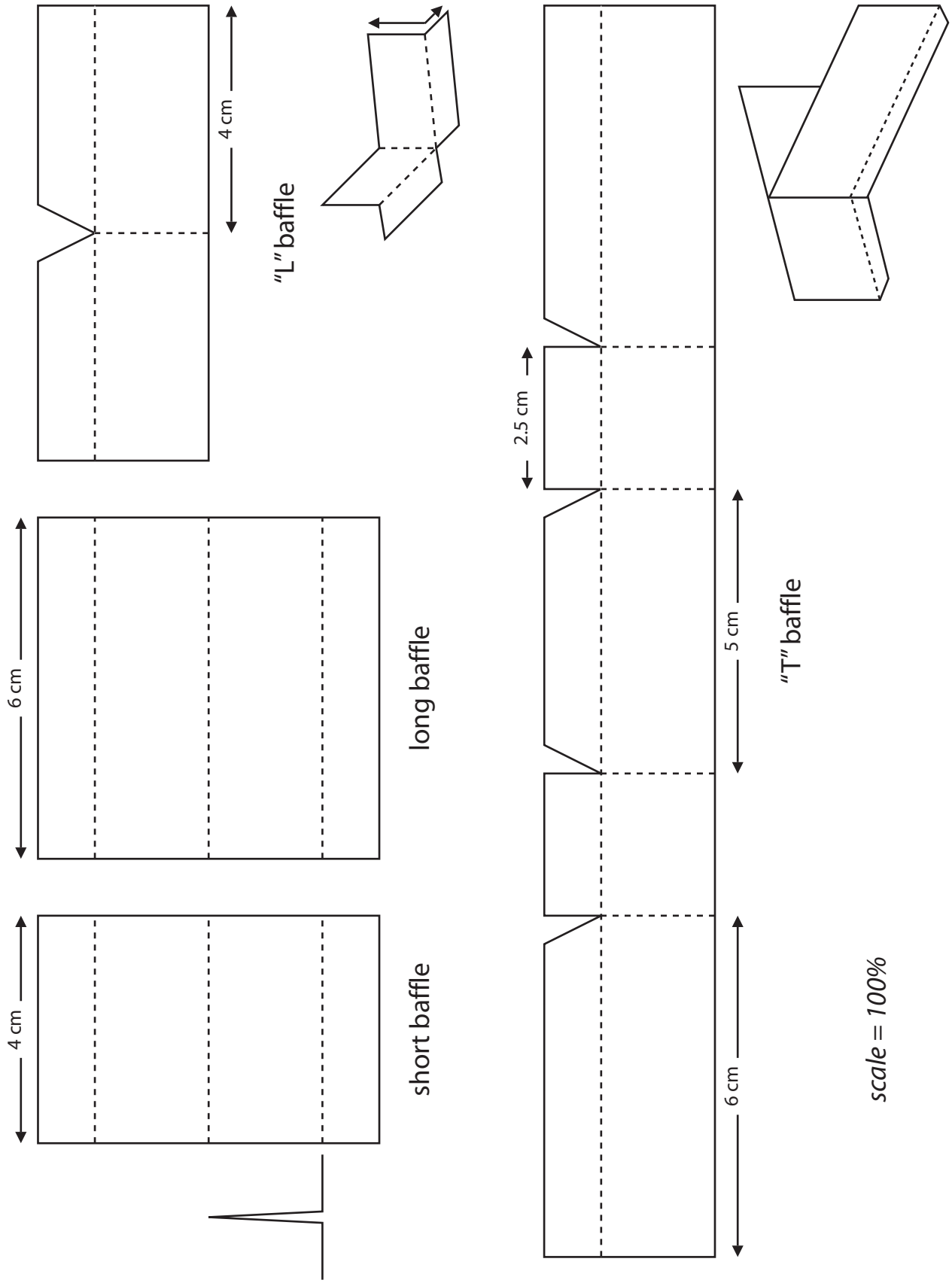
2—NEARLY THERE — Final maze is complete, but difficult to read. Lines are difficult to see and labels are incomplete and/or incorrect. The design appears unfair and/or does not use the template correctly. Meet with the teacher as soon possible to make a plan of action to correct the maze.

1—INCOMPLETE — Final maze is incomplete and unlabeled. The maze is unusable and/or does not use the template. Meet with the teacher as soon possible to make a plan of action to create a new maze.

MARBLE MAZE PATTERN



PATTERN FOR BAFFLES



MARBLE MAZE TIME RECORD

FOR MAZE BOX TEAM: _____

Challenger Names	Time 1	Time 2	Time 3
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
12.			
13.			
14.			
15.			
16.			
17.			
18.			
19.			
20.			
21.			
22.			
23.			
24.			
25.			
26.			
27.			
28.			
29.			
30.			

EXTENSIONS
ORDER OF OPERATIONS CHALLENGE

Directions: Use operations signs to make a true statement for each set of numbers. Use parentheses as needed.

1.	5	3	2	=	10
2.	5	3	2	=	16
3.	5	3	2	=	7.5
4.	5	3	2	=	6
5.	5	3	2	=	17
6.	5	3	2	=	4
7.	5	3	2	=	13
8.	5	3	2	=	30
9.	5	3	2	=	–1
10.	5	3	2	=	$3\frac{2}{3}$
11.	5	3	2	=	$-\frac{1}{3}$
12.	5	3	2	=	1
13.	7	6	3	=	45
14.	7	6	3	=	14
15.	7	6	3	=	126
16.	7	6	3	=	16
17.	7	6	3	=	4
18.	7	6	3	=	10
19.	7	6	3	=	–2
20.	7	6	3	=	39
21.	7	6	3	=	$4\frac{1}{3}$
22.	7	6	3	=	$3\frac{1}{2}$
23.	7	6	3	=	$\frac{1}{3}$
24.	7	6	3	=	3
25.	7	6	3	=	$\frac{7}{18}$
26.	7	6	3	=	$-1\frac{5}{6}$
27.	7	6	3	=	$4\frac{1}{6}$

EXTENSIONS
WRITING ALGEBRA EQUATIONS

Directions: Write the algebra equation for each statement. Use "z" as the variable for each problem. Then solve each equation.

1. The product of a number and twenty-one is two hundred and thirty-one.

2. Sixty-three divided by a number is equal to seven.

3. Nineteen decreased by a number is six.

4. Twenty-two less than a number is ninety-eight.

5. Forty more than a number plus two is one hundred and seven.

6. Multiply a number by sixteen and its product is seven more than two hundred and thirty-three.

7. Seven times a number decreased by five squared is six hundred and seventy-five.

8. Two hundred and thirty-four is fourteen more than a number times eleven.

9. Nineteen minus a number plus forty-nine is sixty.

10. Five times a number minus thirteen equals one hundred and twelve.

ALGEBRA CHAIN 6
COMPLEX PROBLEMS

Directions

1. Your teacher will give the value of the first unknown, z.
2. Use that value in the equation to find the next unknown.
3. Solve the transformation and use each new answer to get you started on solving the next problem by placing that answer in the next box.

z = ☐ Place this value in the box in equation 1.

1. $a - 38 =$ ☐ $a =$ ☐

2. $b +$ ☐ $= 231$ $b =$ ☐

3. $($ ☐ $- 14) - 31 = 760 \div c$ $c =$ ☐

4. $133 + ($ ☐ $+ 7) = d[16 + (2^2 \times 5)]$ $d =$ ☐

5. $e -$ ☐ $[18(900 \div 90)] = 100$ $e =$ ☐

6. $10 + 36 = (545 \div 5) - ($ ☐ $\div 10) + f$ $f =$ ☐

7. $(g - 28) \div (4 + 3) =$ ☐ $- 32$ $g =$ ☐

8. $(h -$ ☐ $) + (3 \times 6_2) \div 9 = \frac{576 \div (1 + 2)}{2}$ $h =$ ☐

9. $($ ☐ $+ 378) - (5^3 \times 4) = i + 24$ $i =$ ☐

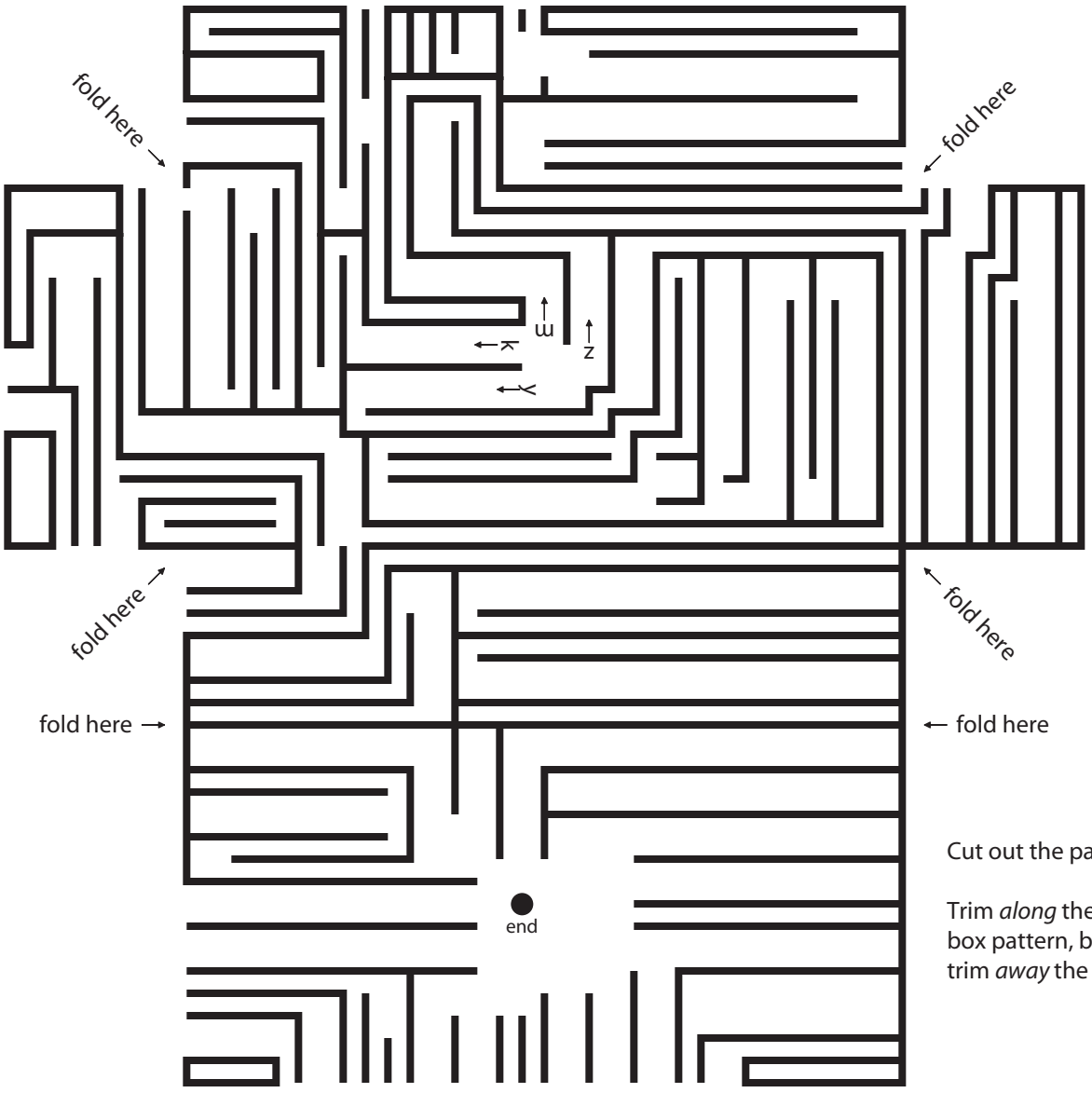
10. $[(5^2 + 4^2) \div 41] + 8 = j -$ ☐ $j =$ ☐

11. $3^3 + 2^3 - k =$ ☐ $- 2$ $k =$ ☐

12. $(5^2 - 2^3 - 8)2 +$ ☐ $= 3 + m$ $m =$ ☐

13. $n + (n \times 3^2) - n =$ ☐ $\times 6$ $n =$ ☐ final answer

MAZE #5



Cut out the pattern carefully.

Trim *along* the edge of the box pattern, but do not trim *away* the outer lines.

EXTENSIONS
WORD PROBLEM CHAIN A

Directions: Solve the word problem chain by writing down the equation and then solving the problem. Place the answer to the first problem in the empty box of the second problem and solve problem 2. Continue using the answer from each problem as a part of the next word problem.

1. You need 15 dollars worth of gas to travel 336 miles to visit your grandmother. How many miles per gallon does your car get if gas costs $1.25 a gallon?

2. Your gas tank holds ☐ gallons and it is 1/4 full. How many gallons of gas must you buy to fill the tank?

3. You plan to pay to have your birthday party catered. The price is $ ☐ per person. The caterer wants 1/5 of the cost as a down payment. If you plan for 30 friends, how much must you give the caterer as a down payment?

4. If you earn $ ☐ in 4 months how much will you earn in one year?

5. The biking club bought 8 mountain bikes at $ ☐ each. What was the total cost including the 6% sales tax?

EXTENSIONS
WORD PROBLEM CHAIN B

Directions: Solve the word problem chain by writing down the equation and then solving the problem. Place the answer to the first problem in the empty box of the second problem and solve problem 2. Continue using the answer from each problem as a part of the next word problem.

1. You purchased 4 items at your favorite store. You purchased a rugby shirt for $15. If your total spent was $119 what did you spend on the other three items combined?

2. You withdrew $ ☐ from your bank account and now have $484 left. How much was in your account before the withdrawal?

3. You sold ☐ cards from your card collection and now you have 303 cards left. How many cards were in your collection before the sale?

4. You had ☐ points in your math class before the final test. Your total is now 980. How many points did you get on the final test?

5. It costs $1500 to purchase the four-wheeler that you want. You need $ ☐ to reach your goal. How much have you already saved?

EXTENSIONS
WORD PROBLEM CHAIN C

Directions: Solve the word problem chain by writing down the equation and then solving the problem. Place the answer to the first problem in the empty box of the second problem and solve problem 2. Continue using the answer from each problem as a part of the next word problem.

1. Your friend bought four tickets for the concert and spent $68. How much do you owe for your ticket?

2. Your school had a big fund raiser for a local charity. ☐ students participated. Each student had a sponsor who paid 75 cents a mile. Each student rode a bike the same number of miles. The students raised $318.75 for the charity. How many miles did each student ride?

3. 20% off the sale price was $ ☐. What was the original price?

4. Last week you worked ☐ hours. This week you worked 10 1/4 hours less and received $189 before taxes. What was your hourly rate?

5. You hire three people to help you move and they each receive the same hourly rate and they help you for ☐ hours. If the bill was $405 how much did they each earn per hour?

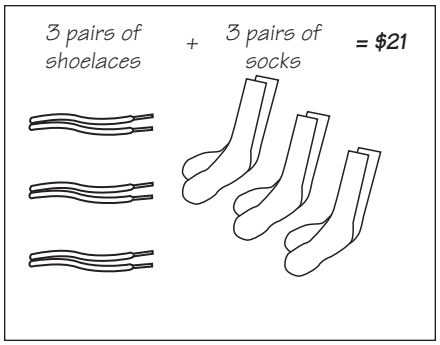
EXTENSIONS
PROBLEM-SOLVING FORMAT SAMPLE

The Problem:
You went shopping and bought 3 pairs of shoelaces that cost $2.60 each. You also bought 3 pairs of wool socks. Altogether you spent $21. What was the cost of one pair of socks?

Directions for explaining your algebra equation:

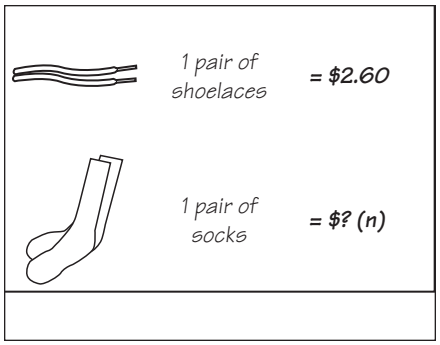
Part I:

1. Read the problem carefully and determine what is being asked. (You may make a simple drawing.)
   I have to find out how much one pair of socks costs.
2. Determine if you need a label in your answer.
   The answer will be labeled using a dollar sign.



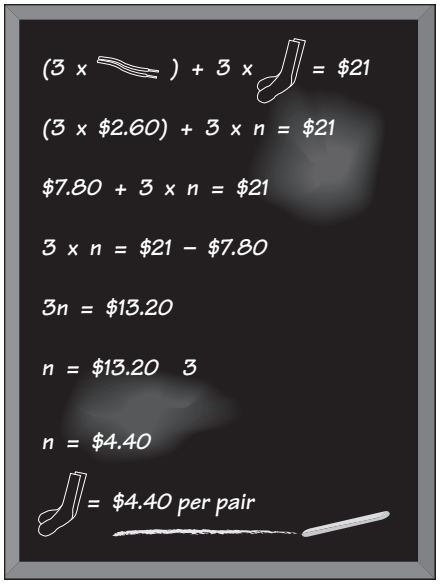
Part II:
List what you know

1. The shoelaces cost $2.60 each.
2. The shoelaces plus the socks costs $21.
3. I bought 3 pairs of shoelaces and 3 pairs of socks



Part III:

1. Identify the variable (n)
   The variable n is (=) the cost of one pair of socks.
2. Write the equation
   (3 × $2.60) + 3 × n = $21
3. Solve the equation.
   $7.80 + 3n = $21
   3n = $21 – $7.80
   3n = $13.20
   n = $4.40



Part IV:
Write down any "insights" you had while solving the problem or while determining the final answer.

If I subtract the amount of money I spent on shoelaces from $21, I will know what I spent on three pairs of socks. Then all I need to do is to divide that number by three.

EXTENSIONS
PROBLEM-SOLVING FORMAT

The Problem:

Part I:

1. Read the problem carefully and determine what is being asked. (You may make a simple drawing.)

2. Determine if you need a label in your answer.

Part II: List what you know

1.

2.

3.

Part III:

1. Identify the variable (*n*)
   The variable n is (=)

2. Write the equation

3. Solve the equation.

Part IV: Write down any "insights" you had while solving the problem or while determining the final answer.

Name _____ **Team** _____

PROBLEM-SOLVING RUBRIC

4—Exemplary

- You correctly found the solution to this problem and clearly and neatly described your process using numbered steps and drawings.
- You also described one or more insights that helped your group to find a solution and showed your understanding of mathematics.

3—Expected

- You correctly found the solution to this problem and clearly and neatly described your process using numbered steps and drawings.

2—Nearly There

- You found the solution to this problem and clearly and neatly described your process using numbered steps and drawings. However, you need to correct it because of one or more of the following
  - — You forgot to label or used the wrong label.
  - — You made a simple computational error.
  - — One of your steps is not clear and needs to be reworded.

1—Incomplete

- Your work needs to be corrected or redone because of one or more of the following:
  - — You made a major error in reasoning.
  - — You made a major error in computation.
  - — Your work is too messy.
  - — Your steps are confusing or not numbered.

Name _____ **Team** _____

PROBLEM-SOLVING RUBRIC

4—Exemplary

- You correctly found the solution to this problem and clearly and neatly described your process using numbered steps and drawings.
- You also described one or more insights that helped your group to find a solution and showed your understanding of mathematics.

3—Expected

- You correctly found the solution to this problem and clearly and neatly described your process using numbered steps and drawings.

2—Nearly There

- You found the solution to this problem and clearly and neatly described your process using numbered steps and drawings. However, you need to correct it because of one or more of the following
  - — You forgot to label or used the wrong label.
  - — You made a simple computational error.
  - — One of your steps is not clear and needs to be reworded.

1—Incomplete

- Your work needs to be corrected or redone because of one or more of the following:
  - — You made a major error in reasoning.
  - — You made a major error in computation.
  - — Your work is too messy.
  - — Your steps are confusing or not numbered.

COOPERATIVE GROUP WORK RUBRIC

4—EXEMPLARY

You *consistently* and *actively* help your group achieve its goals by communicating well with other group members, by encouraging the group to work together, and by *willingly* accepting and completing the necessary work of your daily role.

3—EXPECTED

You *usually* help your group achieve its goals by communicating with other group members, by encouraging your group to work together, and by accepting and completing the necessary work of your daily role.

(If your evaluation is less than EXPECTED,
try to use your cooperating skills more consistently.)

2—You *sometimes* help your group achieve its goals.

1—You *do very little* to help your group achieve its goals.

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ALGEBRA MYSTERY MAZE

STUDENT GUIDE

Introduction

Welcome to ALGEBRA MYSTERY MAZE. In the days ahead you and your team will be in a friendly competition with other teams. You will compete in three different kinds of activities designed to exercise your algebra skills and test your ability to stump other teams.

1. **Solving Algebra Chains**
   Your team's first goal is to be the quickest and most accurate team when solving a series of algebra equations. You earn centimeter lengths (cms) for rapid, accurate work. Use the centimeters to navigate through mazes. Always take advantage of opportunities to earn extra centimeters. A large centimeter total is an advantage for your team.
2. **Navigating Mazes**
   Your second goal is to be the first and most accurate team to navigate a series of mazes. Study each partial maze carefully. Use group decision making to choose the best starting point. Find the shortest route and measure each line segment carefully. Accuracy is crucial.
3. **Designing Individual Mazes**
   Your final goal is to design a tricky maze to stump rival teams. Each member of your team will create a challenging maze for another classmate to solve. Solving such mazes earns centimeters for your team. The penalty for running out of centimeters before completing a maze is a loss of centimeters. The team with the highest centimeter total at the end of the simulation wins.

A *Marble Maze Challenge* is the exciting finale. Your team designs and builds a three-dimensional maze in a box. You challenge other teams to move a marble from one side of the box through to the other side of the box. The other teams compete to race through your maze in the quickest time.

During ALGEBRA MYSTERY MAZE you will meet challenges that require strong math skills and speed. All of you will face mazes that require both accurate measuring skills and group decision making. Pay close attention to the lessons that show you how to write and solve equations. Work cooperatively with your team to maximize your learning and minimize your errors.

Will you work quickly and without error? Will your team earn enough cm lengths to navigate the mazes? Will you choose the best starting positions and follow the shortest pathways? And finally, will you have fun while you become confident algebra students? YES! to all of these questions. But get ready because you will need skill, accuracy, cooperation, and even a little luck to finish first in ALGEBRA MYSTERY MAZE.

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ROLES AND RESPONSIBILITIES

On the most successful teams, all team members work together helping each other to complete the tasks quickly and accurately. (See the **Cooperative Group Work Rubric** in your team folder.)

Recorder

- Leads the team in solving the **Algebra Chain** problems
- Computes the total distance of your team's path through the **Maze**

Designer

- Draws the shortest path through the **Maze**
- Maintains the team's records on the **Tally**

Measurer

- Measures the length of each line segment to the nearest tenth of a centimeter
- Labels the length on each line segment

Algebra Chain 1 **Order of operations**

1. Work from the inside out. Complete the work inside the parentheses ( ), then move to the work inside the brackets [ ].
2. Use the traditional order of operations method: ***P****lease* ***E****xcuse* ***M****y* ***D****ear* ***A****unt* ***S****ally*.
   P stands for *Parentheses*—do the work in the parentheses first
   E stands for *Exponents*—do the exponents second
   M stands for *Multiplication,* ***D*** stands for *Division*—do the multiplication or the division
   A stands for *Addition,* ***S*** stands for *Subtraction*—do the addition or the subtraction
3. Complete multiplication and/or division before completing the addition and subtraction.
4. Work problems from left to right if they contain only addition and/or subtraction.
5. Work problems from left to right if they contain only multiplication and/or division.

Sample word problem #1

You earned \$8 an hour and worked for 9 hours. Your brother worked for 10 hours at \$6 an hour. How much more did you earn than your brother?

($8 × 9) – (10 × $6) = a

$72 – $60 = a

$12 = a You earned \$12 more than your brother earned.

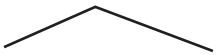
Algebra Chain Rules

1. Solve each problem by following the *Order of operations* procedures.
2. All team members must complete each **Algebra Chain** problem but only the **Recorder's** work will be checked for accuracy. (Sharing information is vital to team success.)
3. Earn centimeter (cm) lengths for every correct answer on the **Algebra Chain** problems.
4. Earn additional cm lengths by being quick to solve the **Algebra Chain** problems.
   (first place = +10 cm; second place = +9 cm, third place = +8 cm, etc.)

MAZE RULES AND ALGEBRA CHAIN 2

Maze Rules

1. Use the cms your team earns completing **Algebra Chains** to move through a maze.
2. As a team, decide the route through the maze.
3. Commit to a maze starting point by circling a symbol or letter.
   a. The team with the highest number of cms selects its starting point first.
   b. The first team to claim a starting point collects 5 cms from all teams who choose the same starting point.
   c. If your team selects a starting point already selected by another team, you must pay that team 5 cms.
   d. You may select another starting point if you do not want to spend any cms.
4. **Designers** lightly sketch the path through the maze. Be as efficient as possible.
   a. Draw only line segments—no curved lines.
   b. No line segment may be shorter than 0**.**2 cm.
   c. No drawn line may touch a maze wall.
5. **Measurers** draw the official route using a ruler.
   a. Measure the line segment lengths (round to nearest tenth cm).
   b. Write measurements on or next to each segment (for example ___2.3 cm___).
   c. Directional changes on the maze must form an angle.



6. **Recorders** add up total cms used and report to the Designer.
7. **Designers** maintain the TALLY.
   a. Record the total cms earned, deducted, or used on the **Tally** before starting a new maze.
   b. Your team ***must stop*** navigating when you have used up all cms earned so far.
   e. It is possible that you may not have enough cms to complete the maze on this day.
8. Earn additional cms by maintaining accurate records and measurements.
   (Accuracy earns +10 cms; Errors earn a deduction of 5 cms *per error*.

Algebra Chain 2 **Substitution of a numerical value for a variable**

1. When a letter (variable) appears next to a number, multiply.
2. Substitute the value of the variable (letter) and multiply by the number.

$5b + 3b = n$	If b equals "7", multiply 5×7 and then multiply 3×7.
$(5 \times 7) + (3 \times 7) = n$	Add the products to get the total.
$35 + 21 = 56$	

Sample word problem #2

You received 3 gift checks from your grandparents and 4 gift checks from your aunts and uncles. You added the gift money to $18 in your savings account. What is your total savings amount now if each gift check was worth $25?

$3b + 4b + \$18 = n$	Substitute $25 for "b" and multiply.
$(3 \times \$25) + (4 \times \$25) + \$18 = n$	
$\$75 + \$100 + \$18 = n$	Now add.
$\$193 = n$	You currently have $193 in savings.

Algebra Chain 3

Transformations involving addition or subtraction

n – 3 = 8	Add 3 to each side of the equation to cancel out the –3 and isolate
+3 = +3	the n on one side of the equation.
n = 11	
n + 5 = –9	Subtract 5 from each side of the equation to cancel out the +5 and
–5 = –5	isolate the n on one side of the equation.
n = –14	
4 + n + 7 = 17	Combine the 4 and the 7.
n + 11 = 17	
–11 = –11	Subtract 11 from both sides of the equation to cancel out the +11
n = 6	and isolate n on one side of the equation.
42 – n = 35	Cancel out the –n by adding +n to both sides leaving the problem
+n = +n	with a positive n value on the right side of the equation.
42 = 35 + n	
–35 = –35	Isolate n on one side of the equation by subtracting 35 from
7 = n	each side.

Sample word problem #3

You have a baseball card collection. Yesterday you sold 19 cards and now your collection has a total of 125 cards. How many cards did you have yesterday morning?

c – 19 = 125	
+19 = +19	
c = 144 cards	You had 144 cards yesterday morning.

Algebra Chain 4 **Transformations involving multiplication and division**

$4n = 32$ Divide each side by 4 to isolate "n" on one side of the equation.

$$\frac{4n}{4} = \frac{32}{4}$$

$n = 8$

Follow the same directions even if the numbers are negative.

$–4n = 17$ Divide each side by –4 to isolate "n" on one side of the equation.

$$\frac{–4n}{–4} = \frac{17}{–4}$$

$n = –4$ **and 1/4**

Follow the same directions even if the unknown forms the numerator of the fraction.

$\frac{n}{4} = 19$ Multiply each side by $\frac{4}{1}$ to isolate "n" on one side of the equation.

$$\frac{n}{4} \times \frac{4}{1} = 19 \times \frac{4}{1}$$

$n = 76$

Sample word problem #4a

Six students worked a car wash and shared the profits. Each share was $26. What was their total profit?

$$\frac{n}{6} = \$26$$

$$\frac{6}{1} \times \frac{n}{6} = \frac{6}{1} \times \$26$$

$n = \$156$

Sample word problem #4b

18 stamps cost the same as 2 milkshakes at $2.88 each. What is the cost of one stamp?

$18s = 2 \times \$2.88$

$18s = \$5.76$ Divide by 18.

$$\frac{18s}{18} = \frac{\$5.76}{18}$$

$s = \$.32$ Each stamp costs $ .32.

Algebra Chain 5 **Using reciprocals to solve algebraic equations containing fractions and decimals**

1. $\frac{1}{4}n = 9$ Multiply each side by $\frac{4}{1}$ to isolate "n" on one side of the equation.

   $\frac{4}{1} \times \frac{1}{4}n = \frac{4}{1} \times 9$ $\frac{4}{1}$ is the reciprocal of $\frac{1}{4}$

   $n = 36$

2. $\frac{2}{5}b = 40$ Multiply each side by $\frac{5}{2}$ to isolate "b" on one side of the equation.

   $\frac{5}{2} \times \frac{2}{5}b = \frac{5}{2} \times 40$ $\frac{5}{2} \times \frac{2}{5} = 1$ and $\frac{5}{2} \times 40 = 100$ $\frac{5}{2}$ is the reciprocal of $\frac{2}{5}$

   $b = 100$

Sample word problem #5a

Mark painted 4/5 of his house with 48 gallons of paint. How much does he need to paint the rest of the house?

$\frac{4}{5}a = 48$ Multiply each side by the reciprocal $\frac{5}{4}$

$\frac{5}{4} \times \frac{4}{5}a = \frac{5}{4} \times 48$ $\frac{5}{4} \times \frac{4}{5} = 1$ and $\frac{5}{4} \times 48 = 60$

$a = 60$ gallons $\frac{5}{4}$ is the reciprocal of $\frac{4}{5}$

Sample word problem #5b

Five students worked at a car wash and shared the profits equally. Two students took home a total of $82. What was the total profit of the car wash? (Hint: Write an equation that says $\frac{2}{5}n = \$82$)

$\frac{2}{5}n = \$82$ Multiply both sides by the reciprocal $\frac{5}{2}$

$\frac{5}{2} \times \frac{2}{5}n = \frac{5}{2} \times \$82$ $\frac{5}{2} \times \frac{2}{5} = 1$ and $\frac{5}{2} \times \$82 = \$205$

$n = \$205$ total profit

3. $.25n = 2.5$ Multiply each side by the reciprocal $\frac{1}{.25}$

   $\frac{1}{.25} \times \frac{.25}{1}n = \frac{1}{.25} \times 2.5$ $\frac{1}{.25}$ is the reciprocal of $\frac{.25}{1}$

   $n = 10$

Sample word problem #5c

The clothes you bought cost $33 on sale, 25% off. What was the original cost? (Write an equation that says $.75n = \$33$.

$.75n = \$33$ Multiply both sides by the reciprocal $\frac{1}{.75}$.

$\frac{1}{.75} \times \frac{.75}{1}n = \frac{1}{.75} \times \$33$ $\frac{1}{.75} \times \frac{.75}{1} = 1$ and $\frac{1}{.75} \times \$33 = \$44$

$n = \$44$ the original cost of the clothes

MARBLE MAZE CHALLENGE

Your team will design a 3-dimensional mystery maze in a box. Your goal is to challenge your classmates with a design so difficult that it will take them a ***long*** time to navigate a marble from one side of the box to another.

1. Construct your marble maze box from the pattern provided. All maze boxes will have the same outside dimensions.
2. Customize the inside of your maze using baffles to cause the marble to change direction.
   - Baffles come in four lengths and styles:
     Short straight baffle — 4 cm long Long straight baffle — 6 cm long
     "L" shaped baffle — 4 cm × 4 cm "T" shaped baffle — 5 cm × 6 cm
3. Your teacher will tell you the cost of each baffle and how many centimeter lengths your team can "spend" to build your maze.
   - Your team may only buy as many baffles as it can afford. (You do not have to spend all your remaining centimeters.)
   - Send the Recorder to the teacher to report what you need. He/she will give you the baffle patterns.

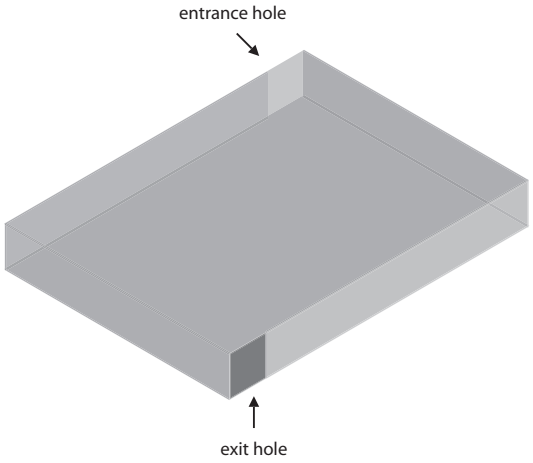
Working as a Team

1. There are four steps in preparing your Marble Maze and a limited amount of time to complete them. Divide responsibilities so everyone on the team is working. For example, while one member is tracing the baffles, the other two can be constructing the box.

2. Share ideas and materials so that you and your team work efficiently. You will need time to see how well your maze works and to make any necessary modifications.

Step 1 Preparing your Marble Maze Box

1. Follow the **Marble Maze Pattern**. Measure and cut the pattern carefully.



Step 2 Designing your Marble Maze

1. Design your route through the box and "buy" the baffles you need.
2. Trace as many baffles as your team is allowed to purchase.

Step 3 Constructing your Marble Maze Box

1. Construct your Marble Maze by folding and taping flaps to top and bottom pieces.
2. Cut and fold the baffles carefully so that they will fit in the box without gaps or peaks.
3. Tape baffles to the inside of the bottom piece according to your planned design. Tape the baffles securely into the box. Some teams draw lines in the box before taping down their baffles to help them follow their plan.

Step 4 Testing your Marble Maze Box

1. Show the teacher your maze before you fold over and tape the top! Do not tape the box too securely. You may need to open it later. (You may want to modify the maze after the test or a marble may get caught inside.)
2. Your teacher will give you a marble. Test your maze to be certain the marble can get through.

How to Solve an Algebra Chain **Recorder in center seat**

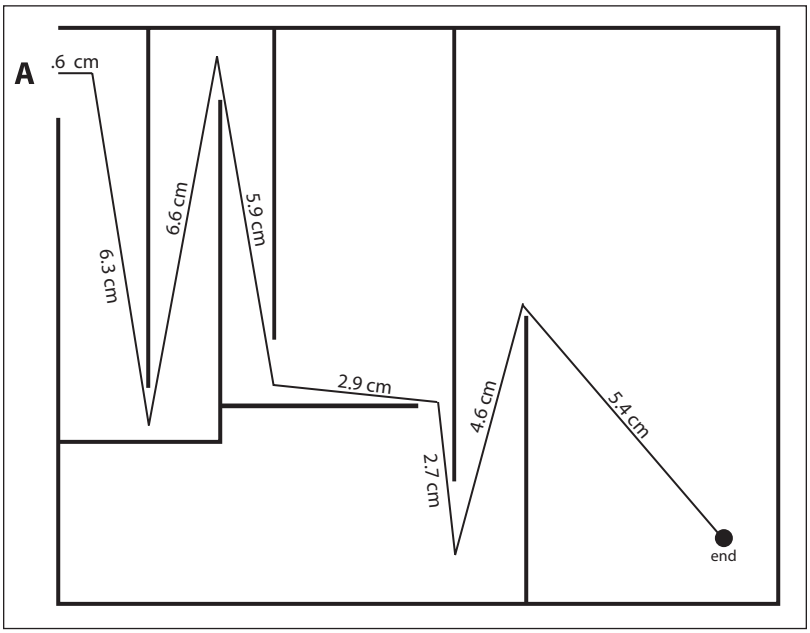
1. Your teacher will give the value of the first unknown.
2. Use that value in the equation to find the next unknown.
3. Use *that* value in the equation to find the next unknown.

Example:

1. Starting value: z . . . . . (z = 4)
2. [(z × 3) ÷ (4 ÷ 2)] = a . . . . . (a = 6)
3. (6 × 6) ÷ (15 – a) = b . . . . . (b = 4)
4. [(30 × 10) + b] ÷ 4 = c . . . . . (c = 76)
5. [(c + 4) ÷ (72 ÷ 9)] = d . . . . . (d = 10)

How to Navigate a Maze **Measurer in center seat**

1. Study the partial maze with a hidden (mystery) section. Determine which starting point will give your team the shortest route.
2. Circle the symbol or letter to commit to your starting point.
3. After seeing the whole maze:
   - The **Designer** will use a ruler to draw straight-line segments through the maze.
     - — All lines must be line segments at least 0.2 cm long.
     - — All turns must form angles (no curves).
     - — No drawn line can touch a line in the maze.
   - The **Measurer** will measure and label the length of each segment.
   - The **Recorder** will compute the total cms used on that maze.
   - The **Designer** will complete the **Tally**.



How to Complete a Tally

Activity	Score	Multiplier (×)	Cms earned	Transfer (+ or –)	Bonus cms	Total cms	Cms used	Cms remaining
Algebra Chain 1	12	× 5	+60	0	+8	68	0	68
Maze #1				–5		63	–37.2	25.8
Algebra Chain 2	10	× 7	+70	0	+10	105.8	0	105.8
Word Problem A	3	× 6	+18	0	0	123.8	0	123.8
Maze #2				+15	0	138.8	–30.7	108.1

