MYSTERIOUS MACHINE

A Simulation of Solving a Scientific Mystery While Learning About Machines

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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. MYSTERIOUS MACHINE is a standards-based program addressing National Science and English Language Arts Standards as set forth within *Content Knowledge: A Compendium of Standards and Benchmarks for K–12 Education,* 3rd Edition, published jointly by the Association for Supervision and Curriculum Development (ASCD) and Mid-continent Research for Education and Learning (McREL). This document gathers standards set by such organizations as the National Research Council (NRC), the National Science Teacher's Association (NSTA), the National Council for Teachers of English (NCTE), and the National Assessment of Educational Progress (NAEP). The content and skills taught in MYSTERIOUS MACHINE are targets of most state frameworks for physical science. The MYSTERIOUS MACHINE simulation provides the opportunity for performance assessment when students apply their science learning and skills to investigate simple machines and to design a machine of their own. The teamwork, record keeping, and problem solving required in the simulation also address standards collectively described as Applied Learning. Level II (Grades 3–5) and Level III (Grades 6–8 or 7–8) Science and English Language Arts met include:

National Science Education Standards

Content Standard A: Abilities necessary to do scientific inquiry

- Design and conduct a scientific investigation.
- Use appropriate tools and techniques to gather, analyze, and interpret data.
- Develop descriptions, explanations, predictions, and models using evidence.
- Think critically and logically to make the relationships between evidence and explanations.
- Recognize and analyze alternative explanations and predictions.
- Communicate scientific procedures and explanations.
- Use mathematics in all aspects of scientific inquiry.

Content Standard B: Physical Science

Position and motion of objects

- An object's motion can be described by tracing and measuring its position over time.
- The position and motion of objects can be changed by pushing or pulling. The size of the change is related to the strength of the push or pull.

Motions and Forces

- If more than one force acts on an object along a straight line, then the forces will reinforce or cancel one another, depending on their direction and magnitude. Unbalanced forces will cause changes in the speed or direction of an object's motion.

STANDARDS

STANDARDS

Transfer of Energy

- Energy is a property of many substances and is associated with heat, light, electricity, mechanical motion, sound, nuclei, and the nature of a chemical. Energy is transferred in many ways.

Content Standard E: Science and Technology

Abilities of Technological Design

- Identify appropriate problems for technological design.
- Design a solution or product.
- Implement a proposed design.
- Evaluate completed technological designs or products.
- Communicate the process of technological design.

NCTE Standards for the English Language Arts

Standard 7 Students conduct research on issues and interests by generating ideas and questions, and by posing problems. They gather, evaluate, and synthesize data from a variety of sources to communicate their discoveries in ways that suit their purpose and audience.

California Applied Learning Standards

Standard 1 Students will understand how to solve problems through a project design process. Students will design a product, service, or system to meet an identified need.

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.

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Reproducible Masters (continued)

Your students solve a mystery involving a unique machine that was found in the workshop of an inventor in the community who recently died. The machine, discovered by the inventor's relatives as they were going through her belongings, incorporates the six simple machines that form the basis for all complex machines. The relatives want to understand what the mysterious machine is and how it might be used. Therefore, the inventor's relatives ask your students to become scientists who work on uncovering the mystery surrounding the machine. As a result of working on this simulation, your students become better prepared to conduct and understand scientific investigations. Using the scientific method during the simulation, students learn to observe, draw conclusions from factual information, and carefully write their conclusions in a Science Journal—just as real scientists do. Specifically, your students will gain the following:

Knowledge

- Understanding of the six simple machines and how each works
- Realization that complex machines are composed of one or more of the six simple machines
- Steps of the scientific method
- Importance of a Science Journal as a place to record information learned during all scientific experiments and observations

Skills

- Conducting experiments using the Scientific Method
- Working as a team of four to six and ultimately, with the entire class
- Accurately collecting and recording scientific data, observations, and questions in a Science Journal
- Applying the knowledge gained solving the scientific mystery to create a working machine

Attitudes

- Developing a sense of teamwork among team members and within the entire class
- Appreciating the learning that takes place during this simulation by keeping and reflecting on the Science Journal
- Gaining confidence using the Scientific Method
- Understanding the significance and prevalence of machines in our world and the fact that machines make our lives easier

OVERVIEW

Most students are fascinated by mysteries as they take pieces of information and see how they fit together to solve a problem. Unfortunately, some students have the impression that all mysteries are connected with murder and suffering because that is what they see on television and in movies. Students need to realize that mysteries are worked on and solved daily in any discipline imaginable including science, history, archeology, health, and education. MYSTERIOUS MACHINE exposes your students to a scientific mystery. As students use the scientific method in this simulation, they work as real scientists do to solve a mystery. This unit excites and challenges students as they actively increase their understanding of the scientific process. Motivated students uncover clues and gain information just as a detective (and scientist) does.

Your students are recruited to help the family of a famous inventor solve a mystery. Michelle Gear, the inventor, completed a fascinating machine right before her death. None of her relatives knows what the machine is or how it can be used, so they are asking your class for assistance in solving this mystery. On the first day of the simulation you will share a diagram of the machine with your class. Using the scientific method, students will make predictions (or hypotheses) about what they believe the machine might do. Receiving daily clues from the Gear family, students will have the opportunity to revise their hypotheses on each day of **Phase 1**, until they uncover the real purpose of the mysterious machine.

Students work in teams to experiment with and learn about six simple machines. Each day, the laboratory explorations focus on one of the six simple machines. In each laboratory exploration, students use the scientific process and keep a careful record of all observations and experiments in their Science Journals.

Students also participate in daily group problem-solving sessions, called T.E.A.M. Activities (**T**ogether **E**veryone **A**ccomplishes **M**ore) which provide additional information about each of the six simple machines. At the end of each day, during a short debriefing session, students discuss what was learned during that day. At the end of Phase 1, students solve the mystery. The final debriefing session during this phase asks students to reflect on what they learned.

Having gained fundamental knowledge about simple machines from Phase 1, students apply that knowledge during **Phase 2**. Again working in teams, students create a machine using at least two of the simple machines. The student-created machines are designed to move a weight (a roll of pennies) a distance of three feet. This activity is not designed to be a competition, since every team in the class could (and hopefully will) successfully accomplish the task. In fact, the more teams who succeed, the more apparent it will be to your students that there are many ways to solve a problem. Consider inviting parents and other members of the school and community (such as local media) to your class on the day that the machines are put to the test.

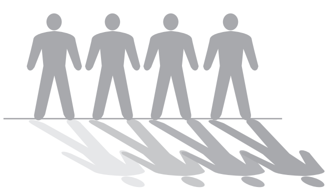
At the end of Phase 2, your class participates in a final debriefing session for MYSTERIOUS MACHINE. This offers students the opportunity to share thoughts and observations, and demonstrates the learning that took place as a result of participating in the simulation.

Like all Interact units, MYSTERIOUS MACHINE provides differentiated instruction through its various learning opportunities. Students learn and experience the knowledge, skills, and attitudes through kinesthetic, hands-on activities. Adjust the level of difficulty as best fits your students when assessing their work, and encourage special needs students to select activities which utilize their strengths and allow them to succeed. Work together with the Resource Specialist, Gifted and Talented Specialist, or other itinerant teacher to coordinate instruction.

SETUP DIRECTIONS

12+ hours

*Take time to carefully look at the schedule and adapt the unit to meet your students' needs. Students may need additional time between Days 12 and 13 for preparing their Team Machines, displays, and oral presentations. Consider allowing an additional day or two for students to create their display boards and machines if necessary (**Phase 2**).*



Cooperative Teams of 4–6

TEACHING TIP

Assign two Project Directors if there are more than five students in a team or if it is beyond a single student's abilities to manage both responsibilities.

1. **Before You Begin**
   Read this entire Teacher Guide become familiar with the elements, lessons, and procedures of the simulation. Study the Student Guide, which contains student materials and student directions. 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 or Lesson on the Unit Time Chart is the length of a normal class period—approximately 60 minutes.
   c. All transparency masters and student handouts are listed by name using all CAPITAL LETTERS.
   d. Teacher reference pages are named in **Bold**.
   e. Student-created materials are named with plain text, beginning with capital letters (e.g., the Science Journal).
   f. Special events are named using *Italics* (e.g., *Machine Day*).

2. **Timing Options**
   MYSTERIOUS MACHINE consists of 12 lessons. The first eight lessons are associated with Phase 1 (solving the mystery). In Phase 2, the final four lessons, students create machines and display boards. The **Unit Time Chart** suggests that you work with each lesson for approximately 60 minutes. You will schedule *Machine Day* following the 12 lessons. *Machine Day* provides students with an opportunity to present their display boards and demonstrate their created machines.

3. **Teaming Students**
   Divide your students in advance into six heterogeneous teams of four to six students each. Strive to establish fair cooperative learning groups by including equal distribution of students' abilities and personalities between teams.

4. **Assigning Roles**
   During Phase 2, after Team Machines are created teams prepare for *Machine Day*. Roles were developed to assist students in designating responsibilities. Assign students to the following roles, or allow teams to determine roles.
   Project Director (one student) — oversee all team *Machine Day* preparations
   a. Supervise all team members as they complete their responsibilities.
   b. Prepare and present an oral presentation explaining how the team used the scientific method to develop their Team Machine.

Simple Machine Experts (two students) — prepare the simple machine display (consulting Science Journals and Team Folder)

a. Prepare *two* sides of the display board.
   - Illustrate the simple machine in action and provide a graph showing how the machine works. Use data from team experiments during the simulation.
   - Write an essay providing background information about the machine and describe in detail what the machine can do.

b. Display at least three objects that use the simple machine in completing their functions.

c. Answer questions about the simple machine on *Machine Day*.

Team Machine Experts (two students) — prepare Team Machine display and demonstration

a. Prepare *one* side of display board.
   - Write an explanation of how the team used the scientific method to develop the Team Machine.
   - Include dates, notes, and experimental data.

b. Demonstrate the Team Machine.

5. **Materials**

The following materials are needed for this unit. Gather materials in advance of the simulation.

Phase 1

- Books (1"–2" thick) — *six same-size books per team*
- Bottles (2–liter plastic; filled with tap water) — *one per team*
- Bowl (small) — *one*
- Cardboard or plywood (approximately 30" square) — *one (Optional)*
- Clay (enough to make a 1–inch ball) — *one per team*
- Composition book or notebook — *class set*
  —OR—
  Construction paper (11" x 17") — *one per student (Science Journal covers) and*
  Lined paper (8.5" x 11") — *at least 10 sheets per student*
- Cups (plastic) — *one per team*
- Desk or table — *two per team*
- Electric hand mixer — *one*
- File folder or construction paper (11" x l7") — *one per team (for team folder)*
- Glue — *several*
- Heavy cream — *one pint or two half-pint containers*
- Hole punch — *one per team*
- Jars (baby food or similar, with lids) — *one per team*

TEACHING TIP

Books should be between 1" and 2" thick. Each team needs two sets of matching books. This will ensure that the table slants in only one direction during the experiment.

- Measuring cup — *one*
- Milk cartons — *two empty half-pint size per team*
- Overhead projector — *one*
- Paper clips (large) — *one per team*
- Pencil (unsharpened) — *one per team*
- Pennies — *50 per team*
- Playground seesaw — *one (Optional)*
- Poster board (9.33" x 11") — *three pieces per team*
- Poster board (4" x 1/2") — *two pieces per team*
- Pulley (1–inch **single**) — *one per team*
- Pulley (1–inch **double**) — *one per team*
- Ruler (12–inch or 30–cm) — *one per team*
- Scissors — *one per team*
- Screwdrivers — *one per team*
- Screws (wood screws of three different sizes and two thread types—coarse and fine) — *six per team*
- Skateboards — *two (Optional)*
- Spring scale — *one per team*
- Stapler — *one*
- Stopwatch (or watch with a stopwatch) — *one*
- String or yarn (roll) — *one*
- Tape (masking) — *one roll per team*
- Tape (transparent) — *one roll per team*
- Toy cars or trucks (various sizes) — *three per team (one small, one medium, one large)*
- Trays (meat trays, cleaned thoroughly) — *one per team*
- Twine (6–foot section) — *one per team*
- Wedge (sample; scrap wood shaped like a wedge) — *one*
- Wood (scrap) — *one per team*

Phase 2

- Chairs or room for seating — *enough for visitors and students*
- Display boards — *one per team*
- Pennies — *one roll per team*
- Tables — *one per team + one*

Teams can use the following materials as they build their Team Machines. Add to or take away items to fit your situation.

- Balloons
- Boxes (small)
- Cans
- Cardboard or poster board
- Cardboard tubes (paper towel or tissue)
- Cups (paper or plastic)
- Drinking Straws
- Film canisters

TEACHING TIP

The pulleys can be found in a hardware store.

Provide three different screw sizes. For each screw size, provide a coarse and fine thread. Each team uses all six.

If your school does not have spring scales, a junior high or high school science class would probably be willing to lend you six for this experiment. Also, teacher supply stores often carry spring scales.

Twine cannot be reused between classes as students will cut their twine as part of the experiment.

An 8–foot length of 2x4 pine can be purchased from a hardware store and cut into pieces by the store or a parent. Make sure that the wood scrap is at least the thickness of the longest screw.

- Hooks
- Modeling clay
- Nuts and bolts
- Paper clips
- Plastic containers (e.g., small margarine tubs)
- Rubber bands
- String
- Tape
- Thread spools
- Toy trucks or cars
- Wire
- Wood (small pieces)
- Wooden building toys

6. **Preparing Materials**
During Phase 1 students complete experiments on Days 2–7. It is recommended that the materials required for each experiment are prepared ahead of time. See specific setup directions included within the Daily Directions for each of these days.

7. **Reproducible Masters**
   - MY SCIENCE JOURNAL — *class set*
   - WHAT I KNOW, WHAT I LEARNED, QUESTIONS I STILL HAVE — *class set + transparency*
   - SCIENTIFIC METHOD — *class set*
   - TIME RECORD — *one*
   - BUTTER GRAPH — *class set + transparency*
   - SCIENCE JOURNAL RUBRIC — *class set or transparency + one to post*
   - T.E.A.M. ACTIVITY RUBRIC — *class set or transparency + one to post*
   - T.E.A.M. ACTIVITY 1 — *one set of strips per team*
   - MACHINE CLUES (Machine Clues 1–6) — *one of each strip per team*
   - INCLINED PLANE EXPERIMENT — *one per team*
   - INCLINED PLANE DATA — *class set*
   - INCLINED PLANE GRAPH — *class set + transparency*
   - T.E.A.M. ACTIVITY 2 — *one set of strips per team*
   - WEDGE PATTERNS — *one set per team*
   - WEDGE EXPERIMENT — *one per team*
   - WEDGE DATA — *class set*
   - WEDGE GRAPH — *class set + transparency*
   - T.E.A.M. ACTIVITY 3 — *one set of strips per team*
   - LEVER EXPERIMENT — *one per team*

TEACHING TIP

Try out the experiments before class to confirm that your students have the skills to assemble the materials and to complete the procedural steps. Adjust the teaching directions accordingly.

- LEVER DATA and LEVER GRAPH — *class set + transparency*
- T.E.A.M. ACTIVITY 4 — *one set of strips per team*
- WHEEL AND AXLE EXPERIMENT — *one per team*
- WHEEL AND AXLE DATA — *class set*
- WHEEL AND AXLE GRAPH — *class set + transparency*
- T.E.A.M. ACTIVITY 5 — *one set of strips per team*
- PULLEY EXPERIMENT — *one per team*
- PULLEY DATA — *class set*
- T.E.A.M. ACTIVITY 6 — *one set of strips per team*
- SCREW EXPERIMENT — *one per team*
- SCREW DATA — *class set*
- SCREW GRAPH — *class set + transparency*
- TEAM MACHINE — *class set*
- MACHINE DAY INSTRUCTIONS — *class set*
- MACHINE RUBRIC — *class set or transparency + one to post*
- DISPLAY RUBRIC — *class set or transparency + one to post*
- ESSAY RUBRIC — *class set or transparency + one to post*
- MACHINE CERTIFICATE — *class set*

8. **Science Journals**
   Each student in the class needs a Science Journal. Plan time every day during class for students to write their observations and conclusions in their journals. MYSTERIOUS MACHINE includes a duplicable MY SCIENCE JOURNAL master to use as a cover.
   a. Students make these journals by gluing their copy of MY SCIENCE JOURNAL to:
      - a composition book or notebook
      - folded construction paper (11" x 17")
   b. Each student's Science Journal should include:
      - WHAT I KNOW, WHAT I LEARNED, QUESTIONS I STILL HAVE handout
      - SCIENTIFIC METHOD handout
      - pockets for additional handouts
      - at least 10 sheets of lined paper

9. **Mysterious Machine Team Folders**
   Prepare a folder for each team of students using file folders or construction paper. During the simulation, students keep all important information they gather in their team folder.

10. **Extensions**
    - **Study Trip** If there is a manufacturing plant nearby that allows visitors, arrange a visit at the end of this simulation. Students may not only learn about the product made at the facility, but they can also be on the lookout for the simple machines contained in the complex machinery observed during the visit.
    - **Guest Speakers** Invite an inventor or a person who works closely with machines to come and speak to your class during or after the simulation. **Note**: Students who understand the Internet can surf the net for information about machines. There may be a scientist out there willing to talk to your students via the computer.

1. **What is Authentic Assessment?**
   Authentic assessment involves looking at more than a single test to judge a student's ability or mastery of content. Assess a student's progress over a period of time. At the end of a unit of study, a student should show thoughtful understanding of a complex idea. A student can demonstrate knowledge and skills orally, in writing, and through photographs, videos, and projects. Interact simulations are ideal tools to use for authentic assessment because they emphasize students facing challenges and producing something to demonstrate their accomplishments.

2. **Achieving Authentic Assessment**
   In MYSTERIOUS MACHINE, students learn and apply the scientific method. They write down thoughts, ideas, observations, and experiments in a Science Journal. The skills and knowledge they acquire will benefit them throughout their lives. Each science journal is both an assessment tool and a demonstration (for administrators, parent, other teachers, etc.) of the learning that has taken place. Use the **Science Journal Rubric** (page 53) for assessment purposes.

   Observe how well students work together in their teams during daily T.E.A.M. Activity problem solving. Use the **T.E.A.M. Activity Rubric** (page 54) for assessment purposes. During the daily debriefing session, assess how well students learned and understand concepts covered that day. If additional discussion is needed, provide that immediately. Of course, the successful completion of daily science activities is also a type of authentic assessment.

3. **Phase 2**
   The entire Phase 2 involves your students in authentic assessment as they apply what they learned in **Phase 1** to create their own Team Machines and to prepare a display of one of the six simple machines. Their displays and explanations—both oral and written—clearly indicate mastery of the concepts of both the simple machines and of the scientific method. Use the **Machine** and **Display Rubrics** (pages 84 and 85) for assessment purposes.

4. **Assessing the Team Machines**
   Not all teams will successfully build a Team Machine that can move the weight the required distance. The more important lesson for students, however, is the understanding and application of the scientific method as they brainstorm, hypothesize, experiment, record data, and draw conclusions. The written records of the process, and the oral and visual presentations of their understanding are at least as valuable as a working Team Machine.

5. **Final Essay**
   Finally, have your students write an essay after they have finished this unit. The essay will demonstrate to each student, you, and others that learning has taken place. As a result, your students will feel a sense of closure and accomplishment. Use the generic **Essay Rubric** (page 86) for assessment purposes.

6. **Determine Assessment Standards**
   MYSTERIOUS MACHINE is designed for students in fourth through eight grades. Therefore, establish your own level of what "meets standard" for your grade level.
   a. "Meeting the standard" on the science journal entries requires that students incorporate requested material (related to the Scientific Method) and process their learning. Require more written elaboration of these skills for more capable students/grades.
   b. "Meeting the standard" on the T.E.A.M. Activities requires students to cooperatively work together as a team.
   c. "Meeting the standard" for *Machine Day* requires students to actively participate in their respective roles as well as work together as a team to prepare a display of one of the six simple machines and to create a machine which incorporates at least two simple machines.
   d. "Meeting the standard" on the optional debriefing essay has two parts, content and writing.
   e. Students who do not "meet the standard" on any part of the assessment must be required to redo that section. Sometimes students need a second chance to demonstrate what they know. Consider allowing students to rewrite their work after reviewing with you. Also consider allowing them to provide their responses orally.

TEACHING TIP

The Science Journal serves various purposes. Decide ahead of time if you will assess only the scientific method component of students' entries or if you will also assess their reflections on learning and hypothesizing on new ideas. Use the ***Science Journal Rubric*** *as appropriate.*

7. **Performance Assessments**
MYSTERIOUS MACHINE includes rubrics to assess student writing, student work, and cooperative team work. Individual students may strive to achieve *Exemplary* using each of these rubrics. Always post rubrics before running the simulation.

8. **What do Rubric Scores Mean?**
When completing performance assessments, focus on "student work." This work is *not* limited to written work. It includes demonstrated skills, oral exchanges, individual and cooperative team 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*
Student work that <u>exceeds the standard</u> for the activity. The descriptor includes words such as "consistently," "complete," "with detail," "actively," and "willingly." Students who earn a "4" demonstrate leadership and knowledge during participation in the simulation.

3 — *Expected*
Student work that <u>meets the standard with quality</u>. 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*
Student work that <u>almost meets the standard</u>. Sometimes inconsistent effort or a misconception of the content will result in a "2" rating. This student needs a little reteaching, needs to try a little harder, or needs to revise his/her work in order to meet the standards described.

1 — *Incomplete*
Student work that <u>has not yet met the standard in content and/or skill</u>. This student will require more instruction and another opportunity to demonstrate a knowledge or skill, or will require alternative instruction and assessment.

UNIT TIME CHART

MYSTERIOUS MACHINE

PHASE 1			
DAY 1	**DAY 2**	**DAY 3**	**DAY 4**
Introduce Simulation • Create Science Journals and Team Folders • Form Cooperative Teams • Butter Experiment • WHAT I KNOW, WHAT I LEARNED,QUESTIONS I STILL HAVE • SCIENTIFIC METHOD • TIME RECORD • BUTTER GRAPH • Science Journal entries	**Inclined Plane Experiment** • T.E.A.M. ACTIVITY 1 • Machine Clue 1 • INCLINED PLANE EXPERIMENT • INCLINED PLANE DATA • INCLINED PLANE GRAPH • Science Journal entries	**Wedge Experiment** • T.E.A.M ACTIVITY 2 • Machine Clue 2 • WEDGE PATTERNS • WEDGE EXPERIMENT • WEDGE DATA • WEDGE GRAPH • Science Journal entries	**Lever Experiment** • T.E.A.M. ACTIVITY 3 • Machine Clue 3 • LEVER EXPERIMENT • LEVER DATA and LEVER GRAPH • Science Journal entries

PHASE 1			
DAY 5	**DAY 6**	**DAY 7**	**DAY 8**
Wheel and Axle Experiment • T.E.A.M. ACTIVITY 4 • Machine Clue 4 • WHEEL AND AXLE EXPERIMENT • WHEEL AND AXLE DATA • WHEEL AND AXLE GRAPH • Science Journal entries	**Pulley Experiment** • T.E.A.M. ACTIVITY 5 • Machine Clue 5 • PULLEY EXPERIMENT • PULLEY DATA • Science Journal entries	**Screw Experiment** • T.E.A.M. ACTIVITY 6 • Machine Clue 6 • SCREW EXPERIMENT • SCREW DATA • SCREW GRAPH • Science Journal entries	**Solve the Mystery**

PHASE 2			
DAY 9	**DAYS 10–11**	**DAY 12**	**DAY 13**
Introduce Team Machine • Brainstorm Team Machine ideas • Science Journal entries document process • TEAM MACHINE • MACHINE RUBRIC	**Develop and Test Team Machines** • Create and test Team Machines • Science Journal entries document process	**Introduce *Machine Day*** • Designate expert groups and assign team roles • Prepare for *Machine Day* presentations • MACHINE DAY INSTRUCTIONS • DISPLAY RUBRIC	***Machine Day*** • Present Display Boards • Present simple machine and team machine • Demonstrate Team Machines • ESSAY RUBRIC • MACHINE CERTIFICATE

Day 1

Objectives
- Introduction to the simulation through background information
- Create Science Journals and Team Folders
- Form cooperative teams
- Read scientific method
- Conduct a scientific experiment (Butter experiment)
- Write Science Journal entries

Materials
- Student Guide — *class set*
- MY SCIENCE JOURNAL — *class set*
- WHAT I KNOW, WHAT I LEARNED, QUESTIONS I STILL HAVE — *class set + transparency*
- SCIENTIFIC METHOD — *class set*
- SCIENCE JOURNAL RUBRIC — *class set or transparency + one to post*
- Glue — *several*
- Overhead projector — *one*
- Stapler — *one*

  —SCIENCE JOURNALS AND TEAM FOLDERS—
- File folder or construction paper (11" x 17") — *one per team (for team folders)*
- Composition book or notebook — *class set*

  —OR—

  Construction paper (11" x 17") — *one per student (Science Journal covers)*

  Lined paper (8.5" x 11") — *at least 10 sheets per student*

  —BUTTER EXPERIMENT MATERIALS—
- TIME RECORD — *one*
- BUTTER GRAPH — *class set + transparency*
- Bowl (small) — *one*
- Electric hand mixer — *one*
- Heavy cream — *one pint or two half-pint containers*
- Jars (baby food or similar size, with lids) — *one per team*
- Measuring cup — *one*
- Stopwatch (or watch with a stopwatch) — *one*

Procedure
1. Distribute the Student Guides. Instruct students to read the letter from Michelle Gear's relatives on the front (page 1). Then have them turn to the back (page 8) and examine the diagram of the mysterious machine.

DAILY DIRECTIONS
DAY 1

PHASE 1

2. Read or tell:

    Michelle Gear's relatives contacted us because they heard that we have a class of hard working scientific detectives. Michelle Gear believed that an education is very important. She encouraged her relatives to do all that they could to support education. They could have taken the mysterious machine to a machine shop or to a university. Instead they decided to bring it to a class of students who were not yet experts in the field. They are following Michelle's wishes to get young people excited about scientific discoveries.

    The only way that we can help the Gear family solve this mystery, is if we act as real scientists do in an organized manner. Our first step is to make a Science Journal.

    Scientists observe and experiment on a regular basis. As they conduct their experiments and make observations, scientists carefully write down what they see and any conclusions they might make. Other scientists who read the notes understand exactly what was observed, even if they weren't there when the experiment was originally done.

    As scientists, we will keep notes in our Science Journals. We will write down everything we learn from our experiments and observations. Be as complete and accurate as possible so that other scientists can duplicate our experiments exactly.

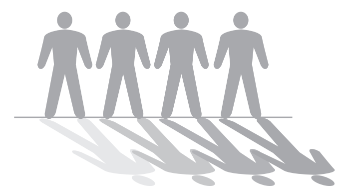
3. Distribute one MY SCIENCE JOURNAL cover to each student. Help students make their journals. Use one of these methods:
    a. Students glue the cover on a folded sheet of construction paper (11" x 17") with at least 10 sheets of lined paper stapled inside.
    b. Students glue the cover onto a regular sheet of lined paper inside a special section of a three-ring notebook.
    c. Students glue the cover to a composition notebook.

    Inform students that they will use their observation skills during class today and will make notations in their Science Journals.

4. Distribute WHAT I KNOW, WHAT I LEARNED, QUESTIONS I STILL HAVE to each student in the class. Tell them to write anything they know about machines in the first column titled *What I Know*. Elicit one example from a student in the class and, using the overhead transparency, demonstrate how to briefly notate the information. This will get the class started.

5. Tell students that they will add to this chart as they work throughout the simulation. As they learn facts about machines, they will note these facts in the *What I Learned* column. At the end of each day they will fill out the column entitled *Questions I Still Have*. Once students have filled out the first section, they place this paper in their Science Journals.

6. Divide students into six teams of four to six students each. Teams will work together throughout the simulation (see **Setup Directions #3, Teaming Students**, for more information).



Cooperative Teams of 4–6

7. Distribute a file folder or construction paper (11" x 17") to each team to make a team folder. Instruct teams to write their names (or the name of their team) on the front of the folder. Direct students to store within this folder all important information they gather in the simulation.

8. Distribute and read SCIENTIFIC METHOD.

9. Inform students that they are going to participate in an activity demonstrating how machines actually make our lives easier. Ask if anyone knows how butter is made. If they don't, tell them that heavy cream is shaken until it separates into butter and water. Tell the class that each team will make butter by shaking heavy cream in baby food jars. At the same time, you will make butter using the hand mixer.

10. Before beginning the activity, review the steps of SCIENTIFIC METHOD and relate them to the experiment you are about to conduct in class.

11. Point out that Step 1 is the *Question*. Explain that the question in a science experiment is what you want to find out. Ask students to state the question for the experiment they are about to perform. Students can work in teams, pairs, or individually to come up with how to phrase the question. Ask students to share their ideas and guide them to state the question simply. One

example might be: "Is it faster to make butter using an electric hand mixer or shaking by hand?" or "Can an electric mixer make butter twice as fast as mixing by hand?"

12. Next discuss Step 2 of the SCIENTIFIC METHOD, the *Hypothesis*. Explain that a hypothesis is an educated guess to answer the question in Step 1. A hypothesis does not have to be correct (scientists will tell you they frequently are not correct), but it should be a guess based on what you know and have observed. Solicit hypotheses from the class about the experiment they are about to do.

13. Discuss Step 3 of the SCIENTIFIC METHOD, the *Experiment*. Scientists conduct experiments according to very exact procedures. It is important for scientists to be accurate when listing the procedure followed in their experiments. If they are accurate, they or other scientists will be able to repeat the experiment and get the same exact results in the future.

14. Tell students that you will discuss the *Data* and *Conclusion* steps of the SCIENTIFIC METHOD after the experiment.

15. Clarify the procedures for the class experiment:
    a. Assign one student to be the timer. Give him or her the stopwatch and the TIME RECORD.
    b. When you say to begin, each group will begin shaking their jars of cream.
    c. No one may begin shaking a jar until you give the *Go* signal.
    d. Students in each group will take turns shaking the baby food jars so that one person doesn't become too tired.
    e. When they first notice that the cream has separated into butter and water, they should say "butter."
    f. The timer will note their time on the TIME RECORD.

16. Conduct the experiment.
    a. Pour two ounces of heavy cream into six baby food jars and into one small bowl.
    b. Distribute the baby food jars to each team.
    c. Say "Go." Turn on the hand mixer at the same time that students begin shaking the cream.
    d. As each group sees that the cream has separated into butter and water, they call out "butter."
    e. The timer notes their time on the TIME RECORD.
    f. Graph the results on the BUTTER GRAPH.

TEACHING TIP

If several students have watches with timers, one member of each group may act as timer for that group.

If a rotary hand mixer is available, you could add the time it takes to make butter using the rotary mixer. This would provide an excellent example of the progression of machines that help people work.

You may also assign one of the students to use the mixer.

17. Distribute BUTTER GRAPH to each student. Tell students that they will now complete Step 4 of the scientific method. They will record their *Data*. Remind them that a scientist conducts the experiment and keeps accurate records of the results in a Science Journal. Often the experiment is repeated a number of times to check for accuracy. In this case, since so many teams did shake the baby food jars, the only portion of the experiment that might be repeated is the electric mixer portion.

18. Tell students:

    Scientists will repeat experiments many times to be sure that results are accurate over time. These results are often charted or graphed to show others who look at the data what information was learned from the experiment. Although a scientist can write out all the data in words, a chart or a graph can often give the same information more clearly and concisely.

19. Show students how to graph the results of the experiment. Using the BUTTER GRAPH transparency, demonstrate how to record the results as a bar graph as students follow along on their individual graphing sheets.

20. Distribute or illuminate SCIENCE JOURNAL RUBRIC and discuss. Guide students through recording the data from this experiment in their Science Journals. Be sure to tell them that each entry in the journal should be dated. Tell your students the following information:

    Scientists date each entry in their Science Journals. Sometimes scientists will have a witness sign their journals. That way, if a new discovery or invention is made as a result of experiments conducted by a scientist, there is a signed record that the scientist can use as proof that s/he was the first to come up with the discovery or invention.

The Science Journal serves various purposes. Decide ahead of time if you will assess only the scientific method component of students' entries or if you will also assess their reflections on learning and hypothesizing on new ideas. Use the ***Science Journal Rubric*** *as appropriate.*

P H A S E 1

21. Tell students that Step 5 of the scientific method is the *Conclusion*.

    When scientists complete their experiment, they develop a conclusion to describe their findings. The conclusion is the last part of the scientific method; it is the place where scientists tell what they learned.

    Scientists arrive at conclusions by carefully looking at their journals, by studying once again the data they collected, and by referring back to their hypothesis. Conclusions must reflect the data collected from the experiments conducted. What conclusion could be make from the experiment that we did today in class?

22. Ask students to suggest possible conclusions for today's experiment. If a general conclusion like "Machines make our lives easier" is given, agree but lead students to make a specific conclusion about the experiment that was done in class.

23. Ask students to think back to the letter from Michelle Gear's family. Instruct them to re-examine the diagram on page 8 of their Student Guides. Tell them to write one more entry in their Science Journals for today—what they predict to be the function of Michelle's mysterious machine.

24. Instruct students to place their copies of SCIENTIFIC METHOD in their Science Journals and their Student Guides, Science Journals, and other relevant information into their Team Folders.

Day 2

Objectives

- Complete T.E.A.M. Activity
- Conduct Inclined Plane Experiment
- Review Machine Clue 1
- Write Science Journal entries

Materials

- T.E.A.M. ACTIVITY RUBRIC — *class set or transparency + one to post*
- T.E.A.M. ACTIVITY 1 — *one set of strips per team*
- Machine Clue 1 (MACHINE CLUES) — *one strip per team*

—TEAM FOLDERS—

- Student Guides
- Science Journals (Student's own)
  - — WHAT I KNOW, WHAT I LEARNED, QUESTIONS I STILL HAVE
  - — SCIENTIFIC METHOD

—INCLINED PLANE EXPERIMENT MATERIALS—

- INCLINED PLANE EXPERIMENT — *one per team*
- INCLINED PLANE DATA — *class set*
- INCLINED PLANE GRAPH — *class set + transparency*
- Books (between 1"–2" thick) — *six same-size books per team*
- Cups (plastic) — *one per team*
- Desk or table — *one per team*
- Hole punch or scissors — *one per team*
- Pennies — *25 per team*
- Rulers (12–inch or 30–cm) — *one per team*
- String or yarn (roll) — *one*
- Tape (masking) — *one roll per team*
- Trays (plastic meat trays, cleaned thoroughly) — *one per team*
- Overhead projector — *one*

Setup

Before class, set up for the experiment as follows:

1. Cut *four* lengths of string that are 10" long and *one* length of string that is 15" long for *each team*.
2. Punch a hole about an inch from one edge of each meat tray.
3. Punch four holes near the rim of each plastic cup, in what would be the four "corners" of each cup.
4. Count out 25 pennies for each team.

TEACHING TIP

Collect and distribute the Team Folders daily. Teams will store their experiment handouts, their data and graph sheets, and each team member's Science Journal in the Team Folder

Individuals will keep individual notes and specific handouts in their Science Journals.

Teams and individuals will add new material to the Science Journals and the Team Folders every day.

Some stores will donate unused meat trays to teachers.

Look at the INCLINED PLANE EXPERIMENT for further clarification of the setup directions.

DAILY DIRECTIONS
DAY 2

PHASE 1

TEACHING TIP

If your class needs the support, you may read the information to them and stop at each point when they need to make notations in their Science Journals.

Procedure

1. Instruct students to get out their Student Guides and Science Journals. List the following words on the board or overhead:
   - Simple machines
   - Force
   - The Law of Conservation of Energy
   - Work
   - Friction

   Instruct students that as they read the background information about machines and how they work, pages 2–3 of their Student Guides, they should write in their Science Journals what each of these words means.

2. Read or tell the following:

   To help us become better informed about simple machines so that we can help Michelle Gear's family, we will start each day with a team problem-solving activity. Please turn to page 7 in your Student Guides and read about the daily T.E.A.M. Activities you will be doing in your team.

3. After students read about the T.E.A.M Activities, distribute or display the T.E.A.M. ACTIVITY RUBRIC and clarify any questions. Emphasize that each team member will participate in the activity. Ask the class for ideas about how a team member who is shy might be helped to participate in the team activity.

4. Distribute the T.E.A.M. ACTIVITY 1 strips, giving each team member a different strip. Inform students that the objective of this activity is to determine which of the six simple machines is described by the clues.

5. When teams have finished this activity, ask which machine they believe was being described. *Answer: Inclined Plane*.

6. Inform students that Michelle Gear's family contacted you. They have found some slips of paper that look like they came from Michelle's Science Journal. Michelle's family thought these notes might provide clues for the class as they try to solve the mystery of Michelle's machine. They will send additional notes to the class as they find them.

TEACHING TIP

Suggest that students refer to the pictures on pages 4–5 in the Student Guide as they consider the clues.

ANSWER KEY

PHASE 1

7. Distribute Machine Clue 1 and have each team examine this clue. Once students have had time to discuss the clue, ask them to put it in their team folders.

8. Distribute an INCLINED PLANE EXPERIMENT to each team. Go over the experiment with the class. Have students examine the setup diagram before you distribute the experiment materials.

9. Ask students to get out their Science Journals and write down today's date. Using the SCIENTIFIC METHOD reviewed yesterday, have the class come up with a *Question* (for instance, "How does an inclined plane work?") and a *Hypothesis* (for instance, "The steeper the slope on an inclined plane, the more pennies will be needed to move the plastic meat tray."). They should note the *Question* and *Hypothesis* in their Science Journals. Point out that the directions given on the INCLINED PLANE EXPERIMENT describe the *Procedure* of the experiment. The *Data* and *Conclusions* will be generated later in the class period.

10. Distribute the following materials to *each team*:
    - INCLINED PLANE DATA — *one per team member*
    - Books (between 1" and 2" thick) — *six same-size books*
    - Cups (plastic) — *one*
    - Hole punch or scissors — *one*
    - Pennies — *25*
    - Ruler (12–inch or 30–cm) — *one*
    - String (15") — *one*
    - String (10") — *four*
    - Tape (masking) — *one roll per team*
    - Trays (plastic meat trays, cleaned thoroughly) — *one*

11. Instruct each team to notify you when the experiment is completely set up so that you can look at each set up before students begin the experiment.

12. Students conduct the Inclined Plane Experiment.

13. Once teams have finished their experiment, distribute an INCLINED PLANE GRAPH to each student. Ask the teams to share the data from their experiments with the class. Using the transparency, demonstrate how to record the results.

PHASE 1

14. Students share conclusions about what they learned about inclined planes from doing this experiment and T.E.A.M. ACTIVITY 1. Instruct students to add information about the *Data* and the *Conclusion* of today's experiment in their Science Journals.

15. Try to elicit where inclined planes are found in the world around us. If students don't mention them be sure to point out wheelchair access ramps and the ramp that extends off the back of a truck so that boxes can be rolled up into the truck.

16. Instruct students to get out their WHAT I KNOW, WHAT I LEARNED, QUESTIONS I STILL HAVE handout. Ask them what they learned today about inclined planes that they didn't know before. Using the overhead transparency, show students how to list these items briefly in note form as they list them on their sheets. Be sure to tell students that not everyone in the class is going to list the same things on their papers because some students have had more experiences in their lives with machines than others. Tell students to add any questions they still have or new questions that came to mind during today's class period.

17. Instruct students to add any notes, reflections, hypotheses, etc. to their Science Journals as appropriate.

Day 3

Objectives

- Complete T.E.A.M. Activity
- Conduct Wedge Experiment
- Review Machine Clue 2
- Write Science Journal entries

Materials

- T.E.A.M. ACTIVITY 2 — *one set of strips per team*
- Machine Clue 2 (MACHINE CLUES) — *one strip per team*
  —TEAM FOLDERS—
  —WEDGE EXPERIMENT MATERIALS—
- WEDGE PATTERNS — *one set per team*
- WEDGE EXPERIMENT — *one per team*
- WEDGE DATA — *class set*
- WEDGE GRAPH — *class set + transparency*
- Milk cartons — *two empty half-pint sizes per team*
- Pennies — *50 per team*
- Rulers (12–inch or 30–cm) — *one per team*
- Scissors — *one per team*
- Tape (transparent) — *one roll per team*
- Poster board (9.33" x 11") — *three pieces per team*
- Poster board (4" x 1/2") — *two pieces per team*
- Wedge (sample; scrap wood shaped like a wedge, or a wedge cut from a piece of wood) — *one*

Setup

Before class, set up for the experiment as follows:

1. Create or locate a sample wedge (scrap wood shaped like a wedge, or a wedge cut from a piece of wood).
2. Cut the poster board into 9.33" x 11" pieces (three pieces per team) and 4" x 1/2" pieces (two pieces per team).

TEACHING TIP

Team Folders include the team members' Student Guides, individual students' Science Journals and the accumulated handouts the students receive. Collect and distribute every day.

TEACHING TIP

Look at WEDGE EXPERIMENT and Day 3's procedure for further clarification of the setup.

PHASE 1

TEACHING TIP

Suggest that students refer to the pictures on pages 4–5 in the Student Guide as they consider the clues.

ANSWER KEY

read or tell

Procedure

1. Instruct students to get out their Student Guides and Science Journals.
2. Distribute T.E.A.M. ACTIVITY 2 strips, giving each team member a different strip. Tell students that once again, the objective of this activity is to determine which of the five remaining simple machines is being described in the clues given.
3. When teams have finished this activity, ask which machine they believe was being described. *Answer: Wedge*.
4. Inform students that you have received a second clue from the Gear family. Distribute Machine Clue 2 and have each team examine the clue. After they have had a short period of time to discuss this clue (and to also look back at Machine Clue 1 if they wish), ask the teams to put the clue in their team folders.
5. Show the class the sample wedge. Instruct students to examine the wedge and then describe it. Students are likely to notice that a wedge looks like a three-dimensional triangle.
6. Inform students that each team will create their own wedges. For the experiment to work well *three wedge sizes* will be used. Distribute WEDGE PATTERNS, a ruler, scissors, tape, and poster board (already cut into three 9.33" x 11" pieces) to each team. To help students construct their wedges give them the following directions:
   a. Trace the three wedge patterns on to your three pieces of poster board.
   b. Cut out the three wedge patterns from the poster board.
   c. Fold the poster board wedge cut outs into wedges with an opening at the top (side opposite the tip).
   d. Tape each wedge together.
   e. Mark a line one inch above the tip of each wedge.
   f. Label the wedges: thin, medium, wide.

PHASE 1

7. Distribute a WEDGE EXPERIMENT to each team. Go over the experiment with the class. Have students examine the setup diagram before you distribute the experiment materials.

8. Ask students to get out their Science Journals and write down today's date. Using the SCIENTIFIC METHOD, have the class come up with a *Question* (for instance, "Which wedge will push the milk cartons apart with the least amount of force?") and a *Hypothesis* (for instance, "The smallest wedge will push the milk cartons apart with the least amount of force."). They should note the *Question* and *Hypothesis* in their Science Journals. Point out that the directions given on the WEDGE EXPERIMENT describe the *Procedure* of the experiment. The *Data* and *Conclusions* will be generated later in the class period.

9. Distribute the following materials to *each team*:
   - WEDGE DATA — *one per team member*
   - Milk cartons (half-pint) — *two (empty)*
   - Pennies — *50*
   - Poster board (4" x 1/2") — *two (already cut)*

10. Instruct each team to notify you when the experiment is completely set up so that you can look at each set up before students begin the experiment.

11. Students conduct the Wedge Experiment.

12. Once teams have finished the experiment, distribute WEDGE GRAPH to each student. Ask the teams to share the data from their experiments with the class. Using the transparency, demonstrate how to record the results.

13. Students share conclusions about what they learned about wedges from doing this experiment and T.E.A.M. ACTIVITY 2. Instruct students to add information about the *Data* and the *Conclusion* of today's experiment in their Science Journals.

14. Try to elicit where wedges are found in the world around us. If students don't mention them be sure to point out doorstops, the wedge used to split a log, a pair of scissors (two wedges), a plow, and a carving knife.

15. Instruct students to get out their WHAT I KNOW, WHAT I LEARNED, QUESTIONS I STILL HAVE handout. Ask them what they learned today about wedges that they didn't know before. Using the overhead transparency, show students how to list these items briefly in note form as they list them on their sheets. Be sure to tell students that not everyone in the class is going to list the same things on their papers because some students have had more experiences in their lives with machines than others. Tell students to add any questions they still have or new questions that came to mind during today's class period.

16. Instruct students to add any notes, reflections, hypotheses, etc. to their Science Journals as appropriate.

Day 4

Objectives
- Complete T.E.A.M. Activity
- Conduct Lever Experiment
- Review Machine Clue 3
- Write Science Journal entries

Materials
- T.E.A.M. ACTIVITY 3 — *one set of strips per team*
- Machine Clue 3 (MACHINE CLUES) — *one strip per team*

  —TEAM FOLDERS—

  —LEVER EXPERIMENT MATERIALS—
- LEVER EXPERIMENT — *one per team*
- LEVER DATA and LEVER GRAPH — *class set + transparency*
- Clay (enough to make a 1–inch ball) — *one per team*
- Pencils (unsharpened) — *one per team*
- Pennies — *seven per team*
- Playground seesaw — *one (Optional)*
- Rulers (12–inch or 30–cm) — *one per team*

Setup
Before class, set up for the experiment as follows:
1. Make six 1–inch balls of clay (one per team).
2. Count out seven pennies for each team.
3. Decide whether you will use the optional seesaw activity (see **Procedure** step 5 for information).

Procedure
1. Instruct students to get out their Student Guides and Science Journals.
2. Distribute T.E.A.M. ACTIVITY 3, giving each team member a different strip. Tell students after doing this activity they will be able to determine which of the four remaining simple machines is being described.

TEACHING TIP

Remind students that they may refer to the pictures on pages 4–5 in the Student Guide as they consider the clues.

ANSWER KEY

TEACHING TIP

T.E.A.M. Activity 3 provides students with the following information:
- *The lever is made up of a rigid body (or a bar) that is used to move a weight or exert force.*
- *The bar pivots around a fixed point called a fulcrum.*
- *There are three classes of levers. The seesaw is an example of a Class 1 Lever.*

Remind students of this information as you complete this optional activity.

3. When teams have finished this activity, ask which machine they believe was being described. *Answer: Lever*.

4. Inform your class that it appears that the Gear family will be sending clues every day. Distribute Machine Clue 3 and have each team of students examine this clue along with previously sent clues. After they have had a short period of time to discuss this clue ask the teams to put the clue in their team folders.

5. **OPTIONAL** If your school has a seesaw, opt to do this activity before beginning today's experiment. Take your class outside to the seesaw and do the following:
   a. Instruct the class to look at the seesaw. Tell them this seesaw is an example of a lever. The support of the lever is located right in the middle of the seesaw. This support is also called the *fulcrum* (pivot point).
   b. Inform the class that when someone sits on a seesaw (even a newborn baby, who hardly weighs anything), a load is created on that arm of the seesaw. Ask one person to sit on one side of the seesaw.
   c. Explain that for this lever to work, effort or force must be added to the other side of the seesaw. Ask a second student to push down the other side of the seesaw and sit on it.
   d. Have these two students adjust where they are sitting on the seesaw until it is balanced without their feet touching the ground.
   e. Have a third and fourth student join each side of the seesaw and have them adjust until they are balanced.
   f. Tell the students on one side of the seesaw that on the count of three they should clap their hands. Observe what happens.
   g. Tell all the students on the seesaw to clap their hands on the count of three. Observe what happens.
   h. After discussing what happened with the seesaw and how it demonstrates a *Class 1 lever*, have the students return to the classroom.

6. Distribute LEVER EXPERIMENT to each team of students. Go over the experiment with the class.

7. Ask students to get out their Science Journals and write down today's date. Using the Scientific Method, ask each team to come up with a *Question* and a *Hypothesis* that would be appropriate for today's experiment. Discuss the results of the team discussions as a class and have students write a *Question*

and *Hypothesis* in their Science Journals. The directions given on the LEVER EXPERIMENT serve as the *Procedure* of the experiment. The *Data* and *Conclusions* will be generated later.

8. Distribute the following materials to *each team*:
   - LEVER DATA and LEVER GRAPH — *one per team member*
   - Clay (1–inch ball) — *one*
   - Pencil (unsharpened) — *one*
   - Pennies — *seven*
   - Ruler (12–inch or 30–cm) — *one*

9. Instruct each team to notify you when the experiment is completely set up so that you can look at each set up before students begin the experiment.

10. Have students conduct the Lever Experiment.

11. Once teams have finished the experiment, ask them to share the results they found doing this experiment. Using the overhead transparency of the LEVER GRAPH, demonstrate how to record the results.

12. After the data has been graphed have students discuss, in their small teams, what they learned about levers from doing the experiment and T.E.A.M. ACTIVITY 3. Discuss as a class. Instruct students to add information about the *Data* and *Conclusions* from today's experiment in their Science Journals.

13. Ask students to describe where levers are used in the world around them. Answers that might be stated are the seesaw, a balance, a mobile, a catapult, and a wheelbarrow.

14. Have students get out WHAT I KNOW, WHAT I LEARNED, QUESTIONS I STILL HAVE while you illuminate the transparency. Instruct them to write some of the things they learned today about levers in the WHAT I LEARNED section of this handout. As students are writing, note some of the ideas expressed orally on your overhead transparency of this handout. Have students add any questions they have to the QUESTIONS I STILL HAVE section of their handouts.

15. Instruct students to add any notes, reflections, hypotheses, etc. to their Science Journals as appropriate.

TEACHING TIP

If your school does not have spring scales, a junior high or high school science class would probably be willing to lend you six for this experiment. Also, teacher supply stores often carry spring scales.

Large variations in the sizes of the toy trucks work best to illustrate this lesson.

Day 5

Objectives

- Complete T.E.A.M. Activity
- Conduct Wheel and Axle Experiment
- Review Machine Clue 4
- Write Science Journal entries

Materials

- T.E.A.M. ACTIVITY 4 — *one set of strips per team*
- Machine Clue 4 (MACHINE CLUES) — *one strip per team*
  —TEAM FOLDERS—
  —WHEEL AND AXLE EXPERIMENT MATERIALS—
- WHEEL AND AXLE EXPERIMENT — *one per team*
- WHEEL AND AXLE DATA — *class set*
- WHEEL AND AXLE GRAPH — *class set + transparency*
- Cardboard or plywood (approximately 30" square) — *one (Optional)*
- Paper clips (large) — *one per team*
- Ruler (12–inch or 30–cm) — *one per team*
- Skateboards — *two (Optional)*
- Spring scale — *one per team*
- Tape (masking) — *one roll*
- Toy cars or trucks (varying sizes) — *three per team (one small, one medium, one large)*

Setup

Before class, set up for the experiment as follows:

1. Put a small piece of masking tape on each of the toy vehicles.
2. Put the toy cars/trucks in sets of three, making sure there is a small, medium, and large vehicle in each set of three.
3. With a pen, put a number on the tape on each vehicle so that the first set of three are numbered 1, 2, 3; the second set of three are numbered 4, 5, 6; the third set 7, 8, 9; etc.
4. Decide ahead of time whether you will complete the optional skateboard activity (see **Procedure** step 5 for more information).

Procedure

1. Instruct students to get out their Student Guides and Science Journals.

2. Distribute T.E.A.M. ACTIVITY 4, giving each team member a different strip. Tell students after doing this activity they will be able to determine which of the three remaining simple machines is being described.

3. When teams have finished this activity, ask which machine they believe was being described. *Answer: Wheel and Axle.*

4. Distribute Machine Clue 4 and have students examine this clue along with all the clues that have been sent so far. After each team has had a short period of time to discuss the clues, ask them to put all the clues back in their folder.

5. **OPTIONAL** If you have access to a large sheet of plywood or cardboard and two skateboards, do this optional activity before doing today's experiment.
    a. Ask one student to sit on the cardboard/plywood sheet. Ask two other students to gently move the student on the cardboard/plywood (Not Too Fast!) by pulling on a corner of the sheet.
    b. Ask the student sitting on the cardboard/plywood to get up. Place the two skateboards under the sheet of cardboard/plywood so that they will support the student (so that this student will no longer be in contact with the floor). Instruct the student to be seated. Make any necessary adjustments.
    c. Ask the same two students to once again gently move the student on the cardboard/plywood sheet (Not Too Fast!) by pulling on a corner of the sheet.
    d. Have the two students who were doing the pulling describe how their work was made easier by adding a wheel and axle to the piece of cardboard/plywood.

6. Distribute WHEEL AND AXLE EXPERIMENT to each team. Go over the experiment with the class.

TEACHING TIP

ANSWER KEY

7. Ask students to get out their Science Journals and write down today's date. Using the Scientific Method, ask students to individually come up with a *Question* and a *Hypothesis* that would be appropriate for today's experiment. Ask students to share their ideas orally. After the discussion have students write a *Question* and a *Hypothesis* in their Science Journals. The directions given on the WHEEL AND AXLE EXPERIMENT serve as the *Procedure* of the experiment. The *Data* and *Conclusions* will be generated later.

8. Distribute the following materials to *each team*:
   - WHEEL AND AXLE DATA — *one per team member*
   - Paper clip (large) — *one*
   - Ruler (12–inch or 30–cm) — *one*
   - Spring scale — *one*
   - Toy cars or trucks (varying sizes) — *three*

9. Instruct each team to notify you when the experiment is completely set up so that you can look at each set up before students begin the experiment.

10. Students conduct the Wheel and Axle Experiment.

11. Once teams have finished the experiment, distribute WHEEL AND AXLE GRAPH to each student. Ask each team to share the results they found doing this experiment. Using the overhead transparency of the WHEEL AND AXLE GRAPH, demonstrate how to record these results.

12. After the data has been graphed have students discuss, in their small teams, what they learned about wheel and axles from doing the experiment and T.E.A.M. ACTIVITY 4. Discuss as a class. Instruct students to add information about the *Data* and *Conclusions* from today's experiment in their Science Journals.

13. Ask students to describe where wheel and axles are found in the world around them. Answers that might be shared include a pencil sharpener, a door handle, a crane, a water well, a window shade, a Ferris Wheel, and a fishing reel.

PHASE 1

14. Have students get out WHAT I KNOW, WHAT I LEARNED, QUESTIONS I STILL HAVE while you illuminate the transparency. Instruct them to write some of the things they learned today about the wheel and axle in the WHAT I LEARNED section of this handout. As students are writing, note some of the ideas expressed orally on your overhead transparency of this handout. Have students add any questions they have to the QUESTIONS I STILL HAVE section of their handouts.

15. Instruct students to add any notes, reflections, hypotheses, etc. to their Science Journals as appropriate.

TEACHING TIP

If students are running out of space on this handout, have them clip additional paper to it or run additional copies.

TEACHING TIP

The pulleys can be found in a hardware store.

If your school does not have spring scales, a junior high or high school science class may lend you six for this experiment. Also, teacher supply stores often carry spring scales.

Look at the PULLEY EXPERIMENT for further clarification on the setup.

TEACHING TIP

Remind students that they may refer to the pictures on pages 4–5 in the Student Guide as they consider the clues.

ANSWER KEY

Day 6

Objectives

- Complete T.E.A.M. Activity
- Conduct Pulley Experiment
- Review Machine Clue 5
- Write Science Journal entries

Materials

- T.E.A.M. ACTIVITY 5 — *one set of strips per team*
- Machine Clue 5 (MACHINE CLUES) — *one strip per team*

  —TEAM FOLDERS—

  —PULLEY EXPERIMENT MATERIALS—
- PULLEY EXPERIMENT — *one per team*
- PULLEY DATA — *class set*
- Bottle (2–liter plastic; filled with tap water) — *one per team*
- Pulley (1–inch **single**) — *one per team*
- Pulley (1–inch **double**) — *one per team*
- Ruler (12–inch or 30–cm) — *one per team*
- Scissors — *one per team*
- Spring scale — *one per team*
- Twine (6–foot section) — *one per team*

Setup

Before class, set up for the experiment as follows:

1. Cut a 6–foot length of twine for each team.
2. Fill the 2–liter bottles with tap water.

Procedure

1. Instruct students to get out their Student Guides and Science Journals.
2. Distribute T.E.A.M. ACTIVITY 5, giving each team member a different strip. Tell students after doing this activity they will be able to determine which of the two remaining simple machines is being described.
3. When teams have finished this activity, ask which machine they believe was being described. *Answer: Pulley*.

4. Distribute Machine Clue 5 and have students examine this clue along with all the clues they have received so far. After students have had a brief period of time to examine and discuss the clues, have them put all the clues away in their team folder.
5. Distribute PULLEY EXPERIMENT to each team. Go over the experiment with the class.
6. Ask students to get out their Science Journals and write down today's date. Using the Scientific Method, ask each team to come up with a *Question* and a *Hypothesis* that would be appropriate for today's experiment. Discuss the results of the team discussions as a class and have students write a *Question* and *Hypothesis* in their Science Journals. The directions given on the PULLEY EXPERIMENT serve as the *Procedure* of the experiment. The *Data* and *Conclusions* will be generated later.
7. Distribute the following materials to *each team*:
   - PULLEY DATA — *one per team member*
   - Bottle (2–liter plastic; filled with tap water) — *one*
   - Pulley (1–inch **single**) — *one*
   - Pulley (1–inch **double**) — *one*
   - Ruler (12–inch or 30–cm) — *one*
   - Scissors — *one*
   - Spring scale — *one*
   - Twine (6–foot section) — *one*
8. Instruct each team to notify you when the experiment is completely set up so that you can look at each set up before students begin the experiment.
9. Students conduct the Pulley Experiment.
10. After the students complete the experiment, have each team of students discuss what *Conclusions* they can reach about the pulley as a result of today's experiment and T.E.A.M. ACTIVITY 5. When the teams have had sufficient time for discussion, ask students to share some ideas with the class. After the class discussion, have students add *Data* and *Conclusions* in their Science Journals.

PHASE 1

TEACHING TIP

If students are running out of space on this handout, have them clip additional paper to it or run additional copies.

11. Ask students to describe where pulleys are found in the world around them. Answers that might be shared include an elevator and a block and tackle.

12. Have students get out WHAT I KNOW, WHAT I LEARNED, QUESTIONS I STILL HAVE while you illuminate the transparency. Instruct them to write some of the things they learned today about the pulley in the WHAT I LEARNED section of this handout. As students are writing, note some of the ideas expressed orally on your overhead transparency of this handout. Have students add any questions they have to the QUESTIONS I STILL HAVE section of their handouts.

13. Instruct students to add any notes, reflections, hypotheses, etc. to their Science Journals as appropriate.

Day 7

Objectives
- Complete T.E.A.M. Activity
- Conduct Screw Experiment
- Review Machine Clue 6
- Write Science Journal entries

Materials
- T.E.A.M. ACTIVITY 6 — *one set of strips per team*
- Machine Clue 6 (MACHINE CLUES) — *one strip per team*

  —TEAM FOLDERS—

  —SCREW EXPERIMENT MATERIALS—
- SCREW EXPERIMENT — *one per team*
- SCREW DATA — *class set*
- SCREW GRAPH — *class set + transparency*
- Desks or tables — *two per team*
- Screwdrivers — *one per team*
- Screws (wood screws of three different sizes and two thread types—coarse and fine) — *six per team*
- Wood scrap (thickness at least equal to the longest screw) — *one per team*

Setup

Before class, set up for the experiment as follows:
1. Find one piece of scrap wood for each team (thickness at least equal to the longest screw).
2. Organize the screws for each team. Put screws in groups of six, making sure there is a coarse and fine thread for each length of screw.

Procedure
1. Instruct students to get out their Student Guides and Science Journals.
2. Distribute T.E.A.M. ACTIVITY 6, giving each team member a different strip. Tell your students that since there is only one simple machine left, they could determine the answer for today's T.E.A.M. activity without even going through the clues that were distributed. **However**, it is important that they do this activity as they have for the past five days in order to learn more information about this simple machine.

TEACHING TIP

Provide three different screw sizes. For each screw size, provide a coarse and fine thread. Each team uses all six.

An 8-foot length of 2x4 white pine can be purchased from a hardware store. It could be cut into pieces by the store or by a parent with woodworking tools.

Consider whether you will use the same type of wood and identical screwdrivers for each team to reduce the experimental variables being examined, or whether you will allow these variables to impact the results of the experiment.

TEACHING TIP

Remind students that they may refer to the pictures on pages 4–5 in the Student Guide as they consider the clues.

ANSWER KEY

3. When teams have finished this activity, ask which machine they believe was being described. *Answer: Screw*.
4. Distribute Machine Clue 6 and have students examine this clue along with all the other clues that have been sent to your classroom. Tell your students that this is the last clue they will receive from the Gear family. Also mention that during class tomorrow teams will be able to share their hypotheses about Michelle's Mysterious Machine. Give teams a short period of time to discuss the clues, then ask them to put all the clues away in their team folder.
5. Distribute SCREW EXPERIMENT and six screws to each team; and SCREW DATA to each student. Go over the experiment with the class. As a class, agree on a number and description (size of screw and thread spacing) for each screw. Instruct students to complete the *Size of Screw* and T*hread Spacing* columns of their SCREW DATA forms.
6. Ask students to get out their Science Journals and write down today's date. Using the Scientific Method, ask each team to come up with a *Question* and a *Hypothesis* that would be appropriate for today's experiment. Discuss the results of the team discussions as a class and have students write a *Question* and *Hypothesis* in their Science Journals. The directions given on the SCREW EXPERIMENT serve as the *Procedure* of the experiment. The *Data* and *Conclusions* will be generated later.
7. Distribute the following materials to *each team*:
   - Screwdriver — *one*
   - Wood scrap (thickness equal to the longest screw) — *one*

   NOTE Remind students that as you discussed previously in class, there are variables that have an effect on an experiment. If you are fortunate enough to have the same type of wood for each team along with identical screwdrivers for each team, all of the variables in the experiment are controlled, except for the size and thread count of the screws. If the same type of wood and screwdrivers are not available for each team, point out that while the experiment directions are the same for each team, the materials they received are not. This will affect the results of the experiment. Your students can discuss the effect of the different materials at the conclusion of the experiment.

TEACHING TIP

The graphic representation of the data will be clearer if you and the students use some order in your screw numbering and description. For example: begin numbering from shortest to longest screw and from fine to coarse threading. The shortest screw with the fine thread would be number one and the longest screw with the coarse thread would be number six.

TEACHING TIP

Any variation in the materials and tools used in the experiment will affect the results of the different teams. Make students aware of these variables as they proceed with their experiments.

8. Instruct each team to notify you when the experiment is completely set up so that you can look at each set up before students begin the experiment.
9. Students conduct the Screw Experiment.
10. **Optional** If time permits, have students exchange the materials that were different—either the screwdrivers or the wood—and discover and discuss how these different materials affect the experiment.
11. Once teams finish the experiment, distribute SCREW GRAPH to each student. Ask each team to share the results they found doing this experiment. Using the overhead transparency of the SCREW GRAPH, demonstrate how to record the results.
12. After the data has been graphed have students discuss, in their small teams, what they learned about screws from doing the experiment and T.E.A.M. ACTIVITY 6. Discuss as a class. Instruct students to add information about the *Data* and *Conclusions* from today's experiment in their Science Journals.
13. Ask students to describe where screws are found in the world around them. Answers that might be shared include a spiral staircase, drilling tools, and a nut and bolt.
14. Have students get out WHAT I KNOW, WHAT I LEARNED, QUESTIONS I STILL HAVE while you illuminate the transparency. Instruct them to write some of the things they learned today about the screw in the WHAT I LEARNED section of this handout. As students are writing, note some of the ideas expressed orally on your overhead transparency of this handout. Have students add any questions they have to the QUESTIONS I STILL HAVE section of their handouts.
15. Instruct students to add any notes, reflections, hypotheses, etc. to their Science Journals as appropriate.

TEACHING TIP

If students are running out of space on this handout, have them clip additional paper to it or run additional copies.

The Mysterious Machine is a perpetual motion machine. *If there were no friction, once it started, it would not stop.*

Use a blank overhead transparency for the letter-writing activity. Have a student or all the students copy the letter to send to Michelle Gear's relatives.

Day 8

Objectives

- Solve the mystery

Materials

—TEAM FOLDERS—

- Student Guides
- Science Journals (Student's own)
  - — WHAT I KNOW, WHAT I LEARNED, QUESTIONS I STILL HAVE
  - — SCIENTIFIC METHOD
  - — MACHINE CLUES (Machine Clues 1–6 already distributed)

Procedure

1. Inform the class that with the information they have gathered over the seven days of the simulation, they have the information needed to solve the mystery of Michelle Gear's Mysterious Machine.

2. Instruct students to get out their Student Guides, Science Journals, MACHINE CLUES (Machine Clues 1–6), and WHAT I KNOW, WHAT I LEARNED, QUESTIONS I STILL HAVE.

3. Instruct students to analyze and sort the information they have gathered. Once they believe they have solved the mystery of Michelle Gear's machine, they are to write their conclusion in their Science Journals.

4. Following the individual analyses, instruct teams to discuss the individual conclusions.

5. Conduct a class discussion of the mysterious machine. A team spokesperson shares each team's conclusions with the class.

6. Once the class has come to a consensus, compose a class letter to Michelle Gear's relatives explaining the class idea about the answer to the mystery.

7. **Optional** Students individually write letters to Michelle Gear's relatives explaining their conclusions about the machine.

8. Instruct students to add any final notes, reflections, etc. to their Science Journals as appropriate.

Days 9–11

Objectives

- Discuss Team Machine
- Brainstorm Team Machine ideas
- Develop and test Team Machine ideas
- Document Team Machine Development in Science Journals
- Create Team Machines

Materials

- TEAM MACHINE — *class set*
- MACHINE RUBRIC — *class set or transparency + one to post*

  —TEAM FOLDERS—

  —TEAM MACHINE MATERIALS—
- Pennies — *one roll per team*

  The following materials will help teams build their team machines. Feel free to add to or take away items on this list.
  - Balloons
  - Boxes (small)
  - Cans
  - Cardboard or poster board
  - Cardboard tubes (paper towel or tissue)
  - Cups (paper or plastic)
  - Drinking straws
  - Film canisters
  - Hooks
  - Modeling clay
  - Nuts and bolts
  - Paper clips
  - Plastic containers (e.g., small margarine tubs)
  - Rubber bands
  - String
  - Tape
  - Thread spools
  - Toy trucks or cars
  - Wire
  - Wood (small pieces)
  - Wooden building toys

Procedure

1. Distribute TEAM MACHINE and read as a class. Clarify any questions.
2. Distribute or illuminate MACHINE RUBRIC and discuss.
3. Instruct groups to brainstorm ideas for their machines, following the guidelines listed on TEAM MACHINE. If there is time, teams begin to develop and experiment with their ideas.
4. Following the guidelines of the Scientific Method teams work together to brainstorm, develop, and experiment with ideas for their Team Machine. Students document this process in their Science Journals.

TEACHING TIP

Make students aware of what materials they will have access to for the purpose of creating their Team Machines.

Days 10–11
Make yourself available to groups as they work, offering materials

TEACHING TIP

Unless your class is very unusual, each team will take a different amount of time to complete its Team Machine activity. Teams who finish their machines early may work on some of these preparation activities, or the entire class may be involved.

5. Additional preparations for **Day 13**—*Machine Day*
   There are a number of other activities that need to be completed to prepare for *Machine Day*. The following ideas will help make *Machine Day* on Day 13 an organized and meaningful experience for your students.
   a. Students create invitations for the people they would like to invite to *Machine Day*. Some obvious choices include parents, the principal, and some other classes. You may also want to invite the local media to attend.
   b. Discuss and decide how the room will be set up for *Machine Day*. You might choose to rearrange desks and chairs in your classroom; or, if the guest list becomes quite long, you might decide to hold the big event in a room that will accommodate all of the people who have been invited to attend.
   c. If videotaping equipment is available at your school, make arrangements to have someone videotape the *Machine Day* event. If this equipment is not available at your school, arrange to have a parent tape and make a copy for your class to enjoy.
   d. Discuss with your class how *Machine Day* will run, so students become familiar with the schedule.

6. **Assessing Student Accomplishments**
   Not all teams will successfully build a Team Machine that can move the weight the required distance. The more important lesson for students, however, is the understanding and application of the scientific method as they brainstorm, hypothesize, experiment, record data, and draw conclusions. The written records of the process, and the oral and visual presentations of their understanding are at least as valuable as a working Team Machine.

Day 12

Objectives

- Each group becomes expert on one of the six simple machines
- Discuss Machine Day Instructions
- Assign team roles
- Display board preparations
- Prepare for Machine Day presentations

Materials

- MACHINE DAY INSTRUCTIONS — *class set*
- DISPLAY RUBRIC — *class set or transparency + one to post*
  —TEAM FOLDERS—
  —MACHINE DAY MATERIALS—
- Display boards — *one per team*

Procedure

1. Designate each of the six groups as "experts" on one of the six simple machines: the inclined plane, the wedge, the lever, the wheel and axle, the pulley, and the screw.
2. Distribute and read MACHINE DAY INSTRUCTIONS. Clarify any questions.
3. Distribute or illuminate DISPLAY RUBRIC and discuss.
4. Assign students to roles or allow groups to choose (see **Setup Directions #4, Assigning Roles** for more information).
5. Instruct groups to discuss ideas for their display. Project Directors lead a discussion of their simple machine and Team Machine. Remind teams to carefully consider the responsibilities outlined on MACHINE DAY INSTRUCTIONS.
6. Instruct students to use all the information from their Student Guides, Science Journals, and all handouts as they work to accomplish their role-based responsibilities.
7. Distribute display boards (one to each team). Students work on their displays and presentations. Circulate through the class to trouble-shoot, make suggestions, and answer questions.
8. Discuss with your class how Machine Day will run, so students become familiar with the schedule.

TEACHING TIP

Team preparations for Machine Day *consist of two activities:*
(1) a team-created machine, composed of at least two simple machines, able to complete a specified task; and
(2) a team display about one of the simple machines.
Teams cooperate to invent their Team Machine. Student responsibilities for preparing the display and oral presentations for Machine Day are divided among team members.

TEACHING TIP

Examples of each type of machine are listed in the Daily Directions for Days 2–7.

Assign two Project Directors if there are more than five students in a team or if it is beyond a single student's abilities to manage both responsibilities.

Make yourself available to groups as they work, offering materials and advice as needed.

Review the Display and Machine Rubrics as necessary.

Be sure to allow enough time between Days 12 and 13 for teams to prepare.

Day 13
Machine Day

Objectives
- Present Display Boards
- Present simple machine and Team Machine
- Demonstrate Team Machines

Materials
- MACHINE CERTIFICATE — *class set*
  —TEAM FOLDERS—
  —DISPLAY MATERIALS—
- Display boards (created by teams) — *one per team*
- Objects that use the simple machine (team determined) — *at least three*
- Tables — *one per team*
  —DEMONSTRATION MATERIALS—
- Team Machines (created by groups) — *one per team*
- Chairs or room for seating — *enough for visitors and students*
- Pennies — *one roll per team*
- Table — *one for demonstrations*

Procedure
1. Instruct teams to set up their display tables. Display tables should include:
   a. Display board
      - Illustrations and graphs regarding their simple machine
      - An informative essay about their simple machine
      - Documentation explaining how their team used the Scientific Method to develop their Team Machine

   b. At least three objects that use of the simple machine in completing their functions
   c. At least one group member available to explain the display board and how each object uses the simple machine in its operation

2. Provide time for the visitors to visit each table.

3. Instruct visitors to take a seat for the Team Machine presentations and demonstrations. Using a separate table at the front of the room, one member presents how the team used the Scientific Method to develop their Team Machine and another member demonstrates the Team Machine to the assembled audience.

TEACHING TIP

Each team should set up in a different area of the room, with its own table. Camping tables brought from home will work for these team displays. If this is not possible, use clustered desks.

If possible, with the aid of parents, serve light refreshments.

4. Award a MACHINE CERTIFICATE to members of each team that achieves the required three feet of distance. After the teams are finished, call for any questions. Each team is given two attempts to demonstrate the Team Machine.

5. Following the Team Machine demonstration, instruct students to make a final entry in their Science Journals about the day's activities. Students complete at home if necessary.

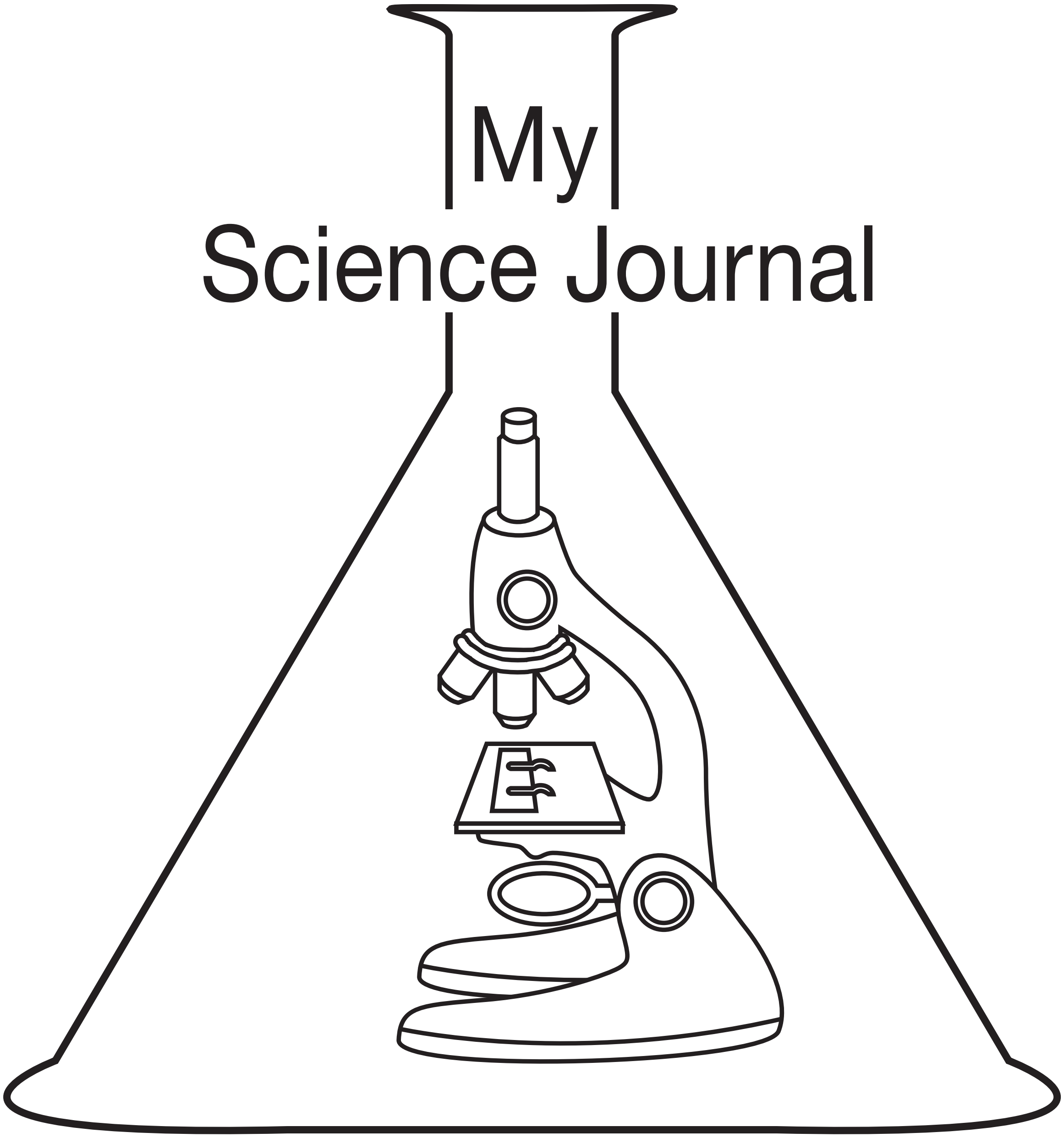
6. Using the **Display** and **Machine Rubrics**, assess student/team performance.

7. **Debriefing** Following *Machine Day*, use one of the following debriefing activities. Both the discussion and the writing activity will bring closure to *Machine Da*y and help students recognize all the learning that took place as a result of participating in this simulation.
   - Conduct a class discussion regarding *Machine Day*, the simulation, machines, etc.
   - Students write an essay about what they learned in this unit of study

TEACHING TIP

Use the ***Essay Rubric*** *on page 86 for assessment purposes.*

My Science Journal



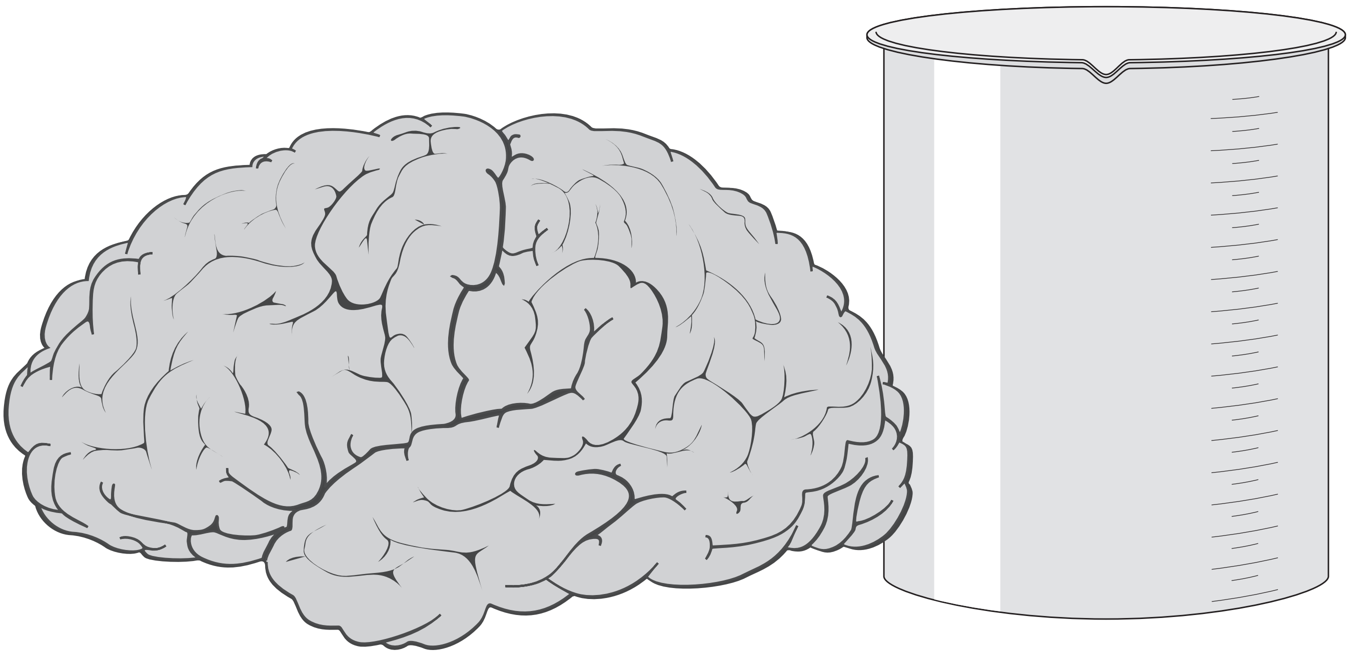
Name: ______________________________

WHAT I KNOW, WHAT I LEARNED, QUESTIONS I STILL HAVE

M Y S T E R I O U S   M A C H I N E

WHAT I KNOW	WHAT I LEARNED	QUESTIONS I STILL HAVE

Using your brain in sequential steps



1. **Problem/Question**: What do you wish to find out?
2. **Hypothesis**: What do you think the answer is?
3. **Experiment**: Design a procedure (experiment) to test your hypothesis.
4. **Data**: Conduct the experiment and keep accurate records of your results. Repeat the experiment several times. Record the information you collect (data) in a Science Journal. (You may also put information on a graph.)
5. **Conclusion**: Summarize what you have discovered (what you conclude) as a result of doing this experiment.

TIME RECORD

Write down the time it takes to shake cream into butter for each of the six teams in your class. Also note the time it takes to mix cream into butter using an electric hand mixer.

TEAMS	TIMES
TEAM 1	
TEAM 2	
TEAM 3	
TEAM 4	
TEAM 5	
TEAM 6	
HAND MIXER	

BUTTER GRAPH

Shade in the amount of time your team took to make butter.

		Teams						
		1	2	3	4	5	6	Hand Mixer
Time	12:00							
	11:30							
	11:00							
	10:30							
	10:00							
	9:30							
	9:00							
	8:30							
	8:00							
	7:30							
	7:00							
	6:30							
	6:00							
	5:30							
	5:00							
	4:30							
	4:00							
	3:30							
	3:00							
	2:30							
	2:00							
	1:30							
	1:00							
	0:30							

SCIENCE JOURNAL RUBRIC

Level 4 — *Exemplary*

- Your entries include all of the relevant Scientific Method components:
  - Date
  - Problem/Question
  - Hypothesis
  - Data
  - Conclusion
- Your reflections, hypotheses, and definitions are exceptionally thoughtful and concise.
- You consistently use correct grammar, punctuation, and spelling.

Level 3 — *Expected*

- Your entries include some of the relevant Scientific Method components:
  - Date
  - Problem/Question
  - Hypothesis
  - Data
  - Conclusion
- Your reflections, hypotheses, and definitions are thoughtful and concise.
- You use correct grammar, punctuation, and spelling.

Level 2 — *Nearly There*

- Your entries include few of the relevant Scientific Method components:
  - Date
  - Problem/Question
  - Hypothesis
  - Data
  - Conclusion
- Your reflections, hypotheses, and definitions are not clear and/or lack evidence of thoughtful reflection.
- You do not always use correct grammar, punctuation, and spelling.

Level 1 — *Incomplete*

- Your entries miss most of the relevant Scientific Method components:
  - Date
  - Problem/Question
  - Hypothesis
  - Data
  - Conclusion
- Your reflections, hypotheses, and definitions are disorganized and/or off topic.
- You seldom use correct grammar, punctuation, or spelling.

T.E.A.M. Activity Rubric

Level 4 — *Exemplary*
- You consistently and actively help your team achieve its goals.
- You consistently communicate with other team members.
- You consistently encourage the team to work together.
- You willingly accept and complete the necessary daily work.

Level 3 — *Expected*
- You help your team achieve its goals.
- You communicate with other team members.
- You encourage the team to work together.
- You accept and complete the necessary daily work.

Level 2 — *Nearly There*
- You sometimes help your team achieve its goals.
- You sometimes communicate with or encourage other team members.
- You do not always accept and complete the necessary daily work.

Level 1 — *Incomplete*
- You do very little to help your team achieve its goals.

T.E.A.M. Activity Rubric

Level 4 — *Exemplary*
- You consistently and actively help your team achieve its goals.
- You consistently communicate with other team members.
- You consistently encourage the team to work together.
- You willingly accept and complete the necessary daily work.

Level 3 — *Expected*
- You help your team achieve its goals.
- You communicate with other team members.
- You encourage the team to work together.
- You accept and complete the necessary daily work.

Level 2 — *Nearly There*
- You sometimes help your team achieve its goals.
- You sometimes communicate with or encourage other team members.
- You do not always accept and complete the necessary daily work.

Level 1 — *Incomplete*
- You do very little to help your team achieve its goals.

T.E.A.M. ACTIVITY 1

Cut this sheet into strips along dotted lines. Give each team member a different strip.

T.E.A.M. Activity 1

1a. This is the most basic of the six simple machines.

This simple machine reduces the force needed to lift an object.

T.E.A.M. Activity 1

1b. This machine resembles a sloping surface.

This machine makes lifting or moving an object easier.

T.E.A.M. Activity 1

1c. This simple machine is unique because it has no moving parts.

An example of this simple machine is a ramp.

T.E.A.M. Activity 1

1d. An example of this simple machine is stairs.

Using this simple machine, you exert less force but you exert it over a longer distance.

T.E.A.M. Activity 1

1e. This simple machine makes up a part of two other simple machines: the wedge and the screw.

The basic shape of this simple machine is a triangle.

T.E.A.M. Activity 1

1f. This simple machine was used in ancient times to help move materials when temples or pyramids were built.

To create a very basic version of this machine, you can place a board on steps that are higher or lower than where you are standing.

MACHINE CLUES

Give each team a Machine Clue each day during Phase 1

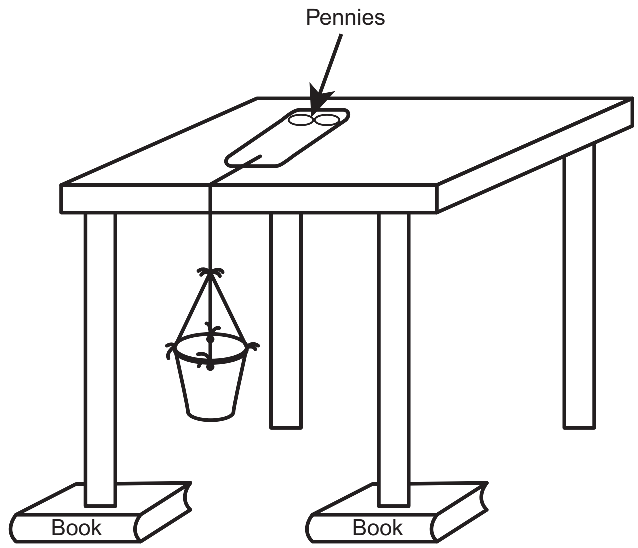
Machine Clue 1 **Day 2**	For this machine to succeed, I need to find a continuous supply of energy.
Machine Clue 2 **Day 3**	As much as possible, I must streamline this machine to minimize the effect of friction.
Machine Clue 3 **Day 4**	Water will be helpful, but I must keep in mind that there must be a constant source of lubrication for this machine.
Machine Clue 4 **Day 5**	Every consideration comes back to overcoming the force of friction.
Machine Clue 5 **Day 6**	The function of this machine is that it can drive itself forever once it is set in motion.
Machine Clue 6 **Day 7**	Have I really been able to achieve the impossible? For hundreds of years people have been trying to design a machine such as mine which will run forever. The motion of this machine goes on and on forever; it is perpetual. Therefore I'm going to call it a ________________ ____________ machine.

INCLINED PLANE EXPERIMENT

Study the diagram as you read the written directions.

Materials

- Books (between 1–2" thick) — *six same-size books*
- Cups (plastic) — *one*
- Desk or table — *one*
- Hole punch or scissors — *one*
- Pennies — *25*
- Rulers (12–inch or 30–cm) — *one*
- String or yarn (10–inch length) — *four*
- String or yarn (15–inch length) — *one*
- Tape (masking) — *one roll*
- Tray (meat tray, cleaned thoroughly) — *one*



Procedure

1. Tie *one end* of each of the 10–inch lengths of string to the four holes in the plastic cup.

2. Tie *one end* of the 15–inch length of string to the small hole in the tray. Tape *five pennies* to the *two* sides of the tray farthest away from the string.
(The 10 pennies add weight and stability to the tray.)

3. Tightly *tie together* the loose ends of the four 10–inch strings. Attach the cup to the tray by tying the loose end of the 15–inch string to the knot(s) where the four strings are tied together.

4. Place *one book* under each of the two legs on one side of the desk. You have just created an inclined plane using your desk.

5. Place the tray *three inches* from the inclined edge of the desk, allowing the plastic cup to dangle over the side. Carefully place pennies, *one at a time*, into the plastic cup until the tray moves to the edge of the desk.

6. On your **Inclined Plane Data** page, record the number of pennies that you added to the cup to move the tray when only one book was used to create the inclined plane.

7. Take the pennies out of the cup. Place a second book on top of the first to make a steeper inclined plane. Repeat step 5 and record your data on your **Inclined Plane Data** page.

8. Take the pennies out of the cup. Place a third book on top of the other two books and repeat the experiment once again. Complete your **Inclined Plane Data** page and indicate to your teacher when you have finished this experiment.

INCLINED PLANE DATA

Cut this sheet along the dotted lines. Give one to each team.

INCLINED PLANE DATA	
ANGLE OF THE INCLINED PLANE	NUMBER OF PENNIES ADDED
ONE-BOOK INCLINED PLANE	
TWO-BOOK INCLINED PLANE	
THREE-BOOK INCLINED PLANE	

INCLINED PLANE DATA	
ANGLE OF THE INCLINED PLANE	NUMBER OF PENNIES ADDED
ONE-BOOK INCLINED PLANE	
TWO-BOOK INCLINED PLANE	
THREE-BOOK INCLINED PLANE	

INCLINED PLANE DATA	
ANGLE OF THE INCLINED PLANE	NUMBER OF PENNIES ADDED
ONE-BOOK INCLINED PLANE	
TWO-BOOK INCLINED PLANE	
THREE-BOOK INCLINED PLANE	

INCLINED PLANE GRAPH

MYSTERIOUS MACHINE

Number of Pennies	Angle of the Inclined Plane: One-Book Inclined Plane	Two-Book Inclined Plane	Three-Book Inclined Plane
15			
14			
13			
12			
11			
10			
9			
8			
7			
6			
5			
4			
3			
2			
1			

T.E.A.M. ACTIVITY 2

Cut this sheet into strips along dotted lines. Give each team member a different strip.

T.E.A.M. Activity 2

2a. This simple machine is two back-to-back inclined planes.

One example of this simple machine is an axe.

T.E.A.M. Activity 2

2b. This machine is an example of a moving inclined plane.

This simple machine is used to raise an object or to split an object apart.

T.E.A.M. Activity 2

2c. Almost all cutting edges make use of this simple machine.

A nail or a pin is an example of this type of simple machine.

T.E.A.M. Activity 2

2d. This machine is usually composed of a piece of wood or a piece of metal that tapers into a very thin edge.

Using this machine, a forward movement can be changed into a parting movement.

T.E.A.M. Activity 2

2e. Rather than moving something up an inclined plane, the plane itself can be moved to raise an object.

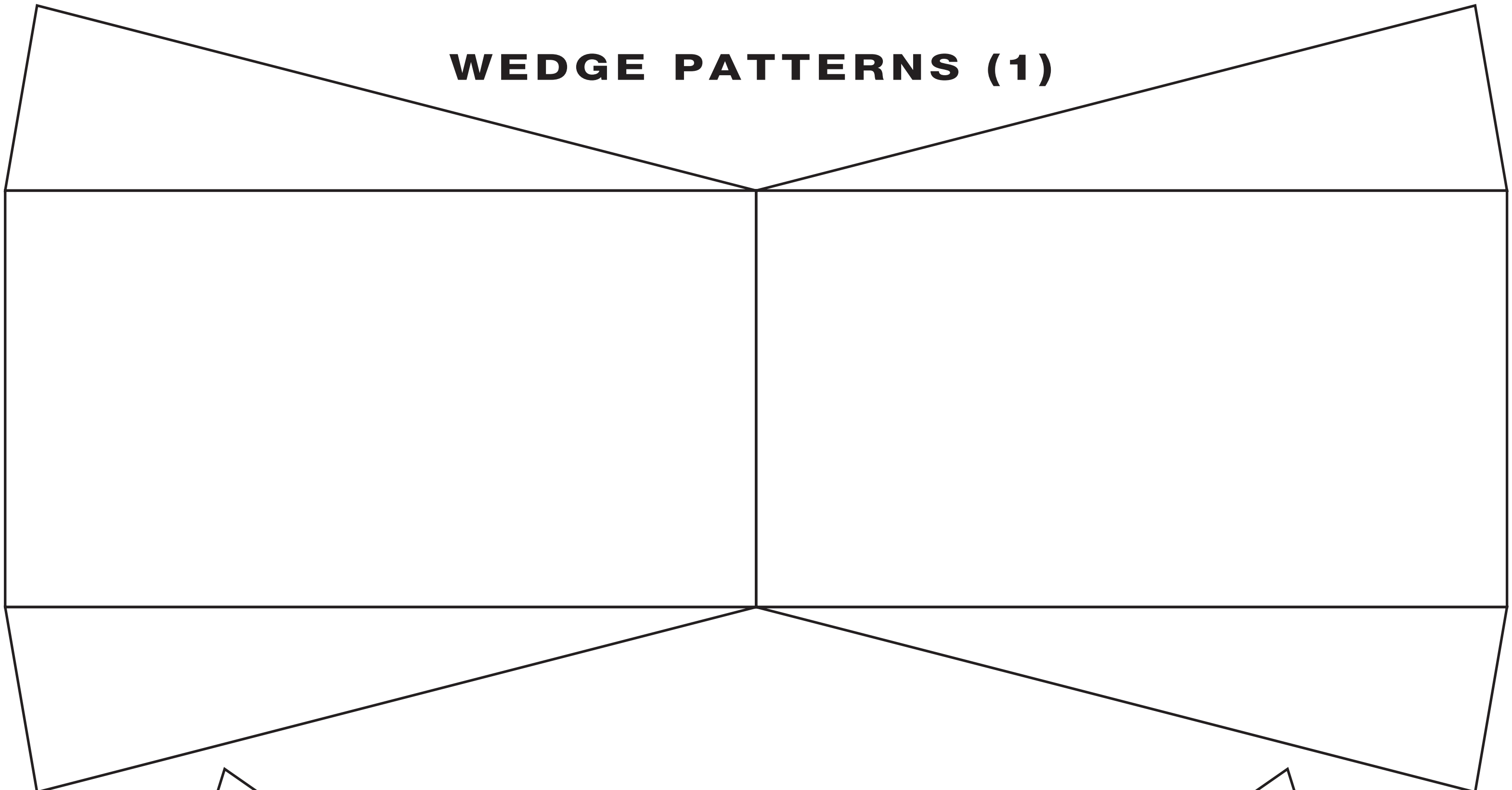
A knife is an example of this simple machine.

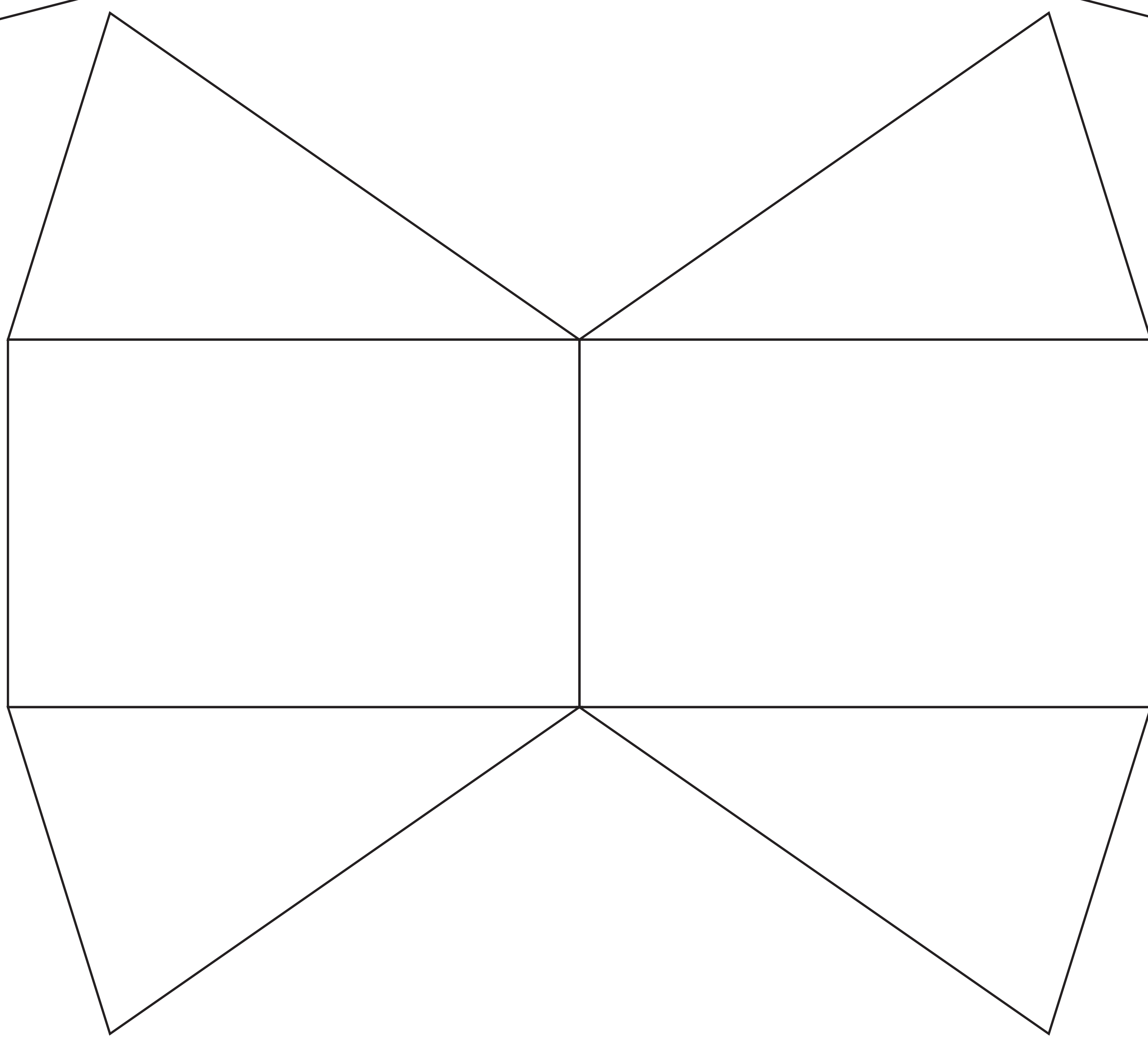
T.E.A.M. Activity 2

2f. Anything with a sharp edge that is used for splitting or cutting is a form of this simple machine.

This machine has been around for at least 5,000 years, when people used it in the form of a plow.

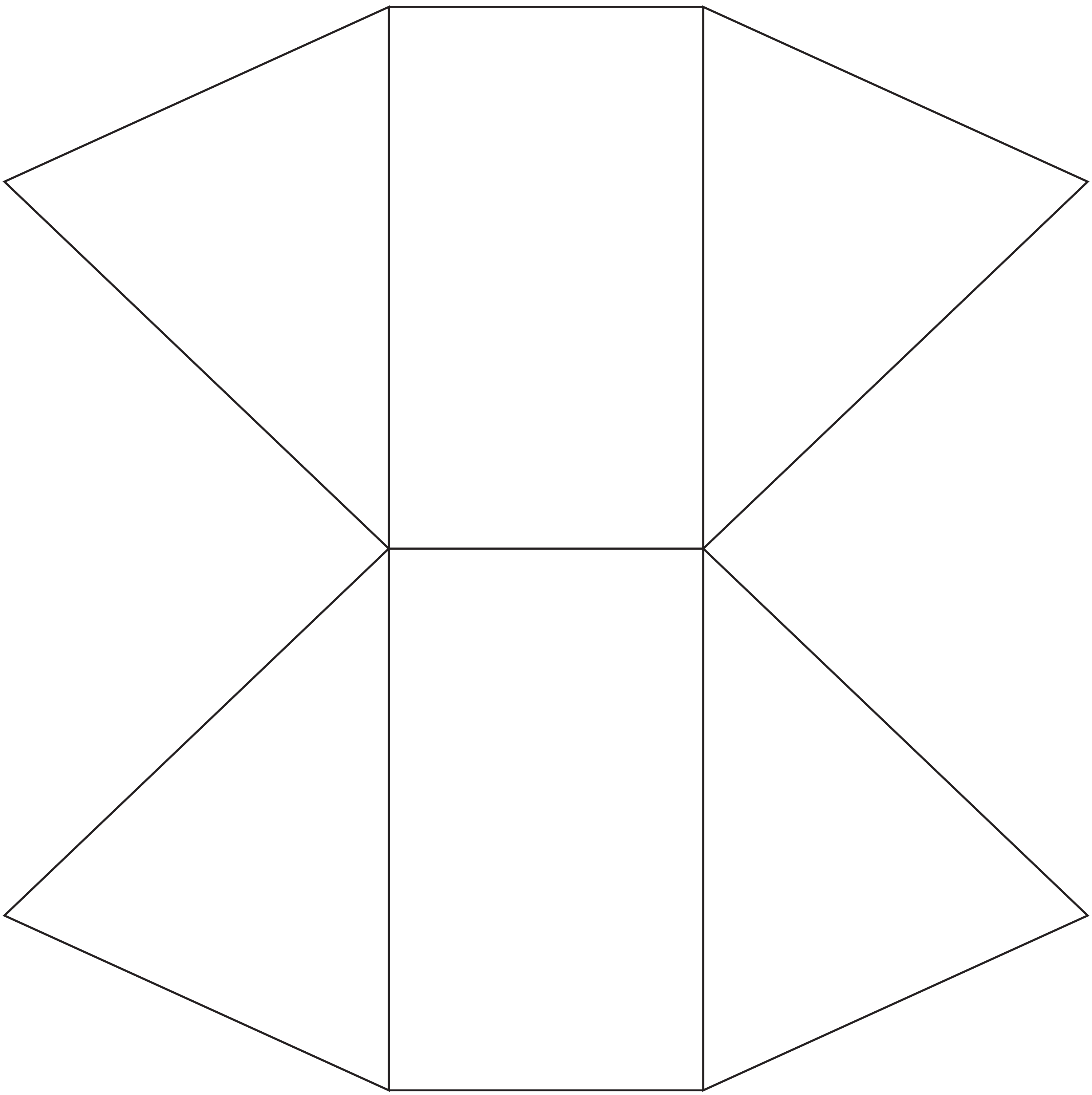
WEDGE PATTERNS (1)



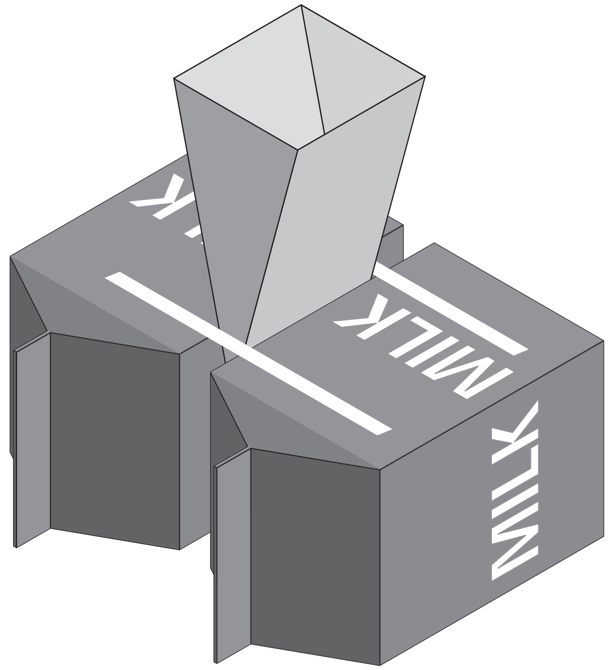


WEDGE PATTERNS (2)

Graphics: see her drawings…two pages



Study the diagram as you read the written directions.



Materials

- **Wedge Patterns** — *one set*
- Milk cartons (half pint) — *two (empty)*
- Pennies — *50*
- Ruler (12–inch or 30–cm) — *one*
- Scissors — *one*
- Tape (transparent) — *one roll*
- Poster board (9.33" x 11") — *three pieces*
- Poster board (4" x 1/2"; "stabilizers") — *two pieces*

Procedure

1. *Cut, fold, and tape* three different wedges (using Wedge Patterns and the three 9.33" x 11" poster board pieces). *Label* the wedges 1 (Thin), 2 (Medium), and 3 (Wide). The top (side opposite tip) of each wedge remains open so you can drop in pennies. Mark a line, one inch from the tip, on each wedge.
2. Place *20 pennies* in *each* milk carton and set them on their sides close together. Tape one side of one of the stabilizers (4" x 1/2" poster board pieces) to one milk carton. Leave the other side unattached, laying on the second milk carton.
3. Place Wedge 1 (Thin), tip side down, between the milk cartons.
   a. One member lines up the 1–inch mark on the wedge with the tops of the milk cartons and holds the wedge in place.
   b. A second member moves the milk cartons together so that they are both touching the wedge.
   c. A third member tapes one side of the second stabilizer strip to the second milk carton, keeping the wedge's 1–inch mark in line with the tops of the milk cartons. Leave the other side of the stabilizer strip unattached, laying on the first milk carton.
   d. The first member lets go of the wedge. The weight of the pennies and the stabilizer strips keep the wedge stable.
4. Add pennies, *one at a time*, until the tip of the wedge hits the top of the desk.
5. Record the number of pennies that were added on your **Wedge Data** page.
6. Repeat steps 3–5 for Wedge 2 (Medium).
7. Repeat steps 3–5 for Wedge 3 (Wide). Complete your **Wedge Data** page and indicate to your teacher when you have finished this experiment.

WEDGE DATA

Cut this sheet along the dotted lines. Give one to each team.

WEDGE DATA	
WEDGES	NUNMBER OF PENNIES ADDED
WEDGE 1 (THIN)	
WEDGE 2 (MEDIUM)	
WEDGE 3 (WIDE)	

WEDGE DATA	
WEDGES	NUMBER OF PENNIES ADDED
WEDGE 1 (THIN)	
WEDGE 2 (MEDIUM)	
WEDGE 3 (WIDE)	

WEDGE DATA	
WEDGES	NUMBER OF PENNIES ADDED
WEDGE 1 (THIN)	
WEDGE 2 (MEDIUM)	
WEDGE 3 (WIDE)	

WEDGE GRAPH

MYSTERIOUS MACHINE

# of Pennies			
10			
9			
8			
7			
6			
5			
4			
3			
2			
1			
	WEDGE 1 (THIN)	**WEDGE 2 (MEDIUM)**	**WEDGE 3 (WIDE)**
	Wedges		

T.E.A.M. ACTIVITY 3

Cut this sheet into strips along dotted lines. Give each team member a different strip.

T.E.A.M. Activity 3

3a. There are three different classes of this type of simple machine—Class 1, Class 2, and Class 3.

This simple machine consists of the following components: a fulcrum, resistance, resistance arm, effort, and effort arm.

T.E.A.M. Activity 3

3b. The Class 1 version of this machine is the most common.

In the Class 1 version of this machine, the fulcrum is located between the resistance and the effort.

T.E.A.M. Activity 3

3c. Examples of the Class 1 version of this machine are: the seesaw, the crowbar, the balance scale, and a pair of pliers.

Archimedes said, "If I had a place to stand and a ________________________ long enough, I could move the world."

T.E.A.M. Activity 3

3d. The Class 2 version of this machine has the resistance and the effort arm on the same side of the fulcrum. The resistance is located between the fulcrum and the effort.

Examples of a Class 2 version of this machine are: bottle openers, wrenches, wheelbarrows, and nutcrackers.

T.E.A.M. Activity 3

3e. The Class 3 version of this machine has the effort and the resistance on the same side of the fulcrum. The effort is located between the fulcrum and the resistance.

Some examples of the Class 3 version of this machine are: fly swatters, golf clubs, fishing rods, hammers, and brooms.

T.E.A.M. Activity 3

3f. This machine is made up of a rigid body (or a bar) that is used to move weight or exert force. The bar pivots around a fixed point called a fulcrum.

LEVER EXPERIMENT

Study the diagram as you read the written directions.

Materials

- Clay
- Pencil (unsharpened) — *one*
- Pennies — *seven*
- Ruler (12–inch or 30–cm) — *one*

Procedure

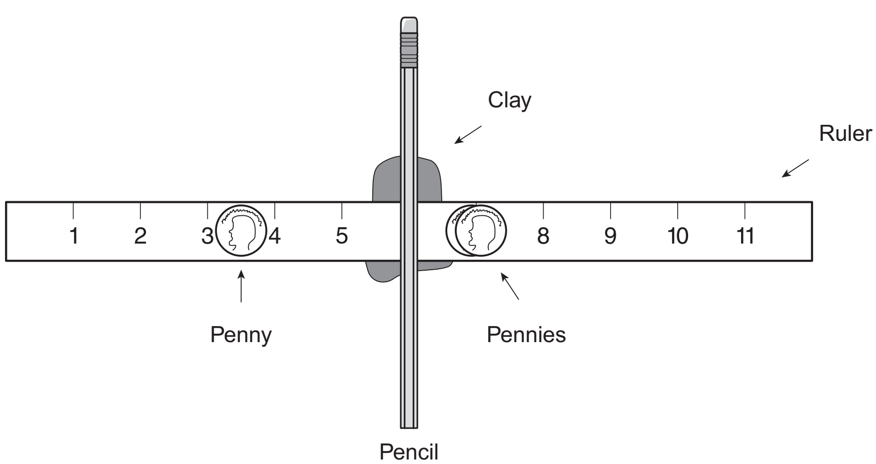
1. *Roll* the clay into an elongated ball. *Place* the pencil firmly, without burying it, in the clay on a desk. (The pencil will act as the fulcrum that your lever will pivot on.) Place the ruler on top of the pencil (at the 6–inch mark) so that it balances on the pencil.

2. Put *one penny* at the 7–inch mark (one inch to the right of the fulcrum). Slide *one penny* along the ruler, beginning just to the left of the pencil (fulcrum), until this penny lifts and balances the penny placed at the 7–inch mark. (If your set up is balanced, the pennies should be the same distance from the fulcrum.) On your **Lever Data** page, record how far from the fulcrum the single penny was placed.

3. Stack a *second penny* on top of the first penny at the 7–inch mark. Slide *one penny* along the ruler, beginning just to the left of the pencil (fulcrum), until this penny lifts and balances the pennies placed at the 7–inch mark. On your **Lever Data** page, record how far from the fulcrum the single penny was placed.

4. Continue this process with stacks of three, four, five, and six pennies. Record your data indicating how far from the fulcrum the single penny must be placed to lift and balance each stack of pennies.

5. Complete your **Lever Data** sheet and indicate to your teacher when you have finished this experiment.



LEVER DATA AND GRAPH

MYSTERIOUS MACHINE

LEVER DATA

Mark how many inches from the fulcrum one penny lifts each stack of pennies.

	Number of Pennies Lifted					
	1	2	3	4	5	6
Inches From Fulcrum						

LEVER GRAPH

Shade in the *distance from the fulcrum* one penny *lifts each stack of pennies*.

Distance (Inches) From Fulcrum							
	6 inches						
	5 inches						
	4 inches						
	3 inches						
	2 inches						
	1 inch						
		1	2	3	4	5	6
		Number of Pennies Lifted					

T.E.A.M. ACTIVITY 4

Cut this sheet into strips along dotted lines. Give each team member a different strip.

T.E.A.M. Activity 4

4a. This simple machine is made up of two parts.

One part of this simple machine is considered one of the greatest inventions of all time.

T.E.A.M. Activity 4

4b. In this machine, something round turns around a rod.

An example of this kind of machine is the screwdriver.

T.E.A.M. Activity 4

4c. An example of this type of machine is the old fashioned well: a crank turns a wooden axle which raises a bucket because the rope attached to the bucket wraps around the axle and lifts the bucket.

A gear and a pulley are two special types of this simple machine.

T.E.A.M. Activity 4

4d. How the two parts of this machine work can vary—sometimes one part of this machine works independently of the other; at other times the two parts work together.

An example of this kind of simple machine is a yo-yo.

T.E.A.M. Activity 4

4e. This machine is like a pulley with a handle attached that is used to turn a part of this machine.

Waterwheels are an example of this simple machine.

T.E.A.M. Activity 4

4f. This machine is actually a form of the lever but it can move a load further than a simple lever can.

Other examples of this type of simple machine are: the wheel on a bicycle, windmills, and the faucet.

WHEEL AND AXLE EXPERIMENT

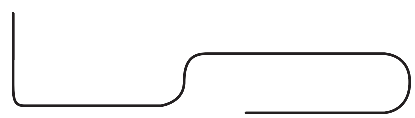
Study the diagrams as you read the written directions.

Materials
- — Paper clip (large) — *one*
- — Ruler (12–inch or 30–cm) — *one*
- — Spring scale — *one*
- — Toy cars or trucks (varying sizes) — *three*

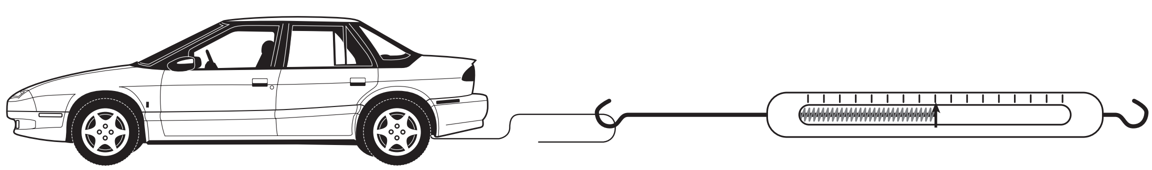
Procedure
After you finish doing this experiment with the first three vehicles, trade vehicles with another team. That way, the class will have repeated experimentation with each set of vehicles, and each member of each team will have the opportunity to experiment with one set of vehicles.

1. Examine each of the three toy cars and trucks. Determine where the wheel and axle are located on each. Additionally, locate the vehicle's number. (The number is written on a small piece of masking tape.)

2. Open the large paper clip you were given so it looks like this:



3. Attach one side of the paper clip to the first car or truck and the other side of the paper clip to the spring scale (as shown in the following diagram):



4. Hold onto the spring scale. Using a steady even motion, pull the first vehicle along the table or the floor. When you have achieved a very steady, even motion, note the number indicated on the spring scale. Write the the spring scale number next to the correct car or truck number on your **Wheel and Axle Data** page.

5. Repeat this experiment with each of the vehicles your team was given.

6. At your teacher's direction, pass your set of three vehicles to another team and receive a new set of vehicles. Repeat this process until your team has experimented on each vehicle brought to class.

7. Record all of the data for each vehicle on **Wheel and Axle Data** page and indicate to your teacher when you have finished this experiment.

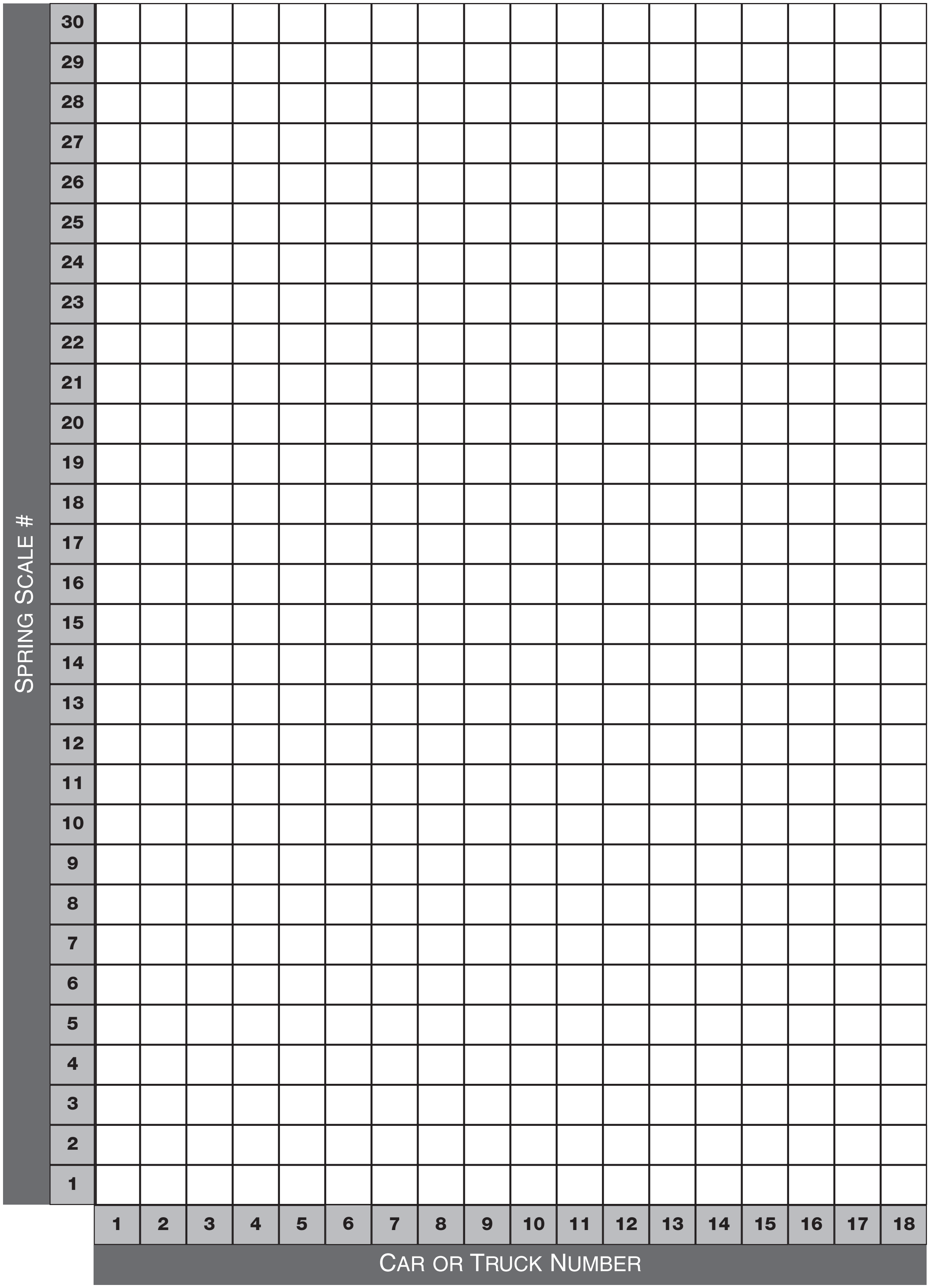
WHEEL AND AXLE DATA

MYSTERIOUS MACHINE

CAR OF TRUCK NUMBER	SPRING SCALE NUMBER
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	

WHEEL AND AXLE GRAPH

MYSTERIOUS MACHINE



T.E.A.M. ACTIVITY 5

Cut this sheet into strips along dotted lines. Give each team member a different strip.

T.E.A.M. Activity 5

5a. This machine is composed of a wheel with a groove around the edge of the rim in which a rope, belt, or chain fits.

This simple machine is a form of the wheel.

T.E.A.M. Activity 5

5b. An elevator is an example of this simple machine because as an elevator moves up, a counterweight moves down. As an elevator moves down, the counterweight moves up.

There are two types of this simple machine—fixed and movable.

T.E.A.M. Activity 5

5c. A fixed type of this machine does not move—it helps us do things more easily by changing the directions of the force.

Even though this machine is a type of wheel, it fits into small spaces more easily than a traditional wheel does.

T.E.A.M. Activity 5

5d. A movable type of this machine moves along the rope, chain, or belt. This version of the machine helps us gain force, but, in this case, the force must be applied over a larger distance.

This simple machine is very useful because pulling a rope down to lift an object is more comfortable than lifting that object up directly.

T.E.A.M. Activity 5

5e. A block and tackle is an example of a system of this type of machine.

In a single version of this simple machine, the resistance and the effort move an equal distance.

T.E.A.M. Activity 5

5f. This machine works in the following way: when a heavy object is attached to one end of a rope/chain and the rope is wound around the rim of a wheel, the heavy object can be moved by pulling on the other end of the rope.

PULLEY EXPERIMENT (1)

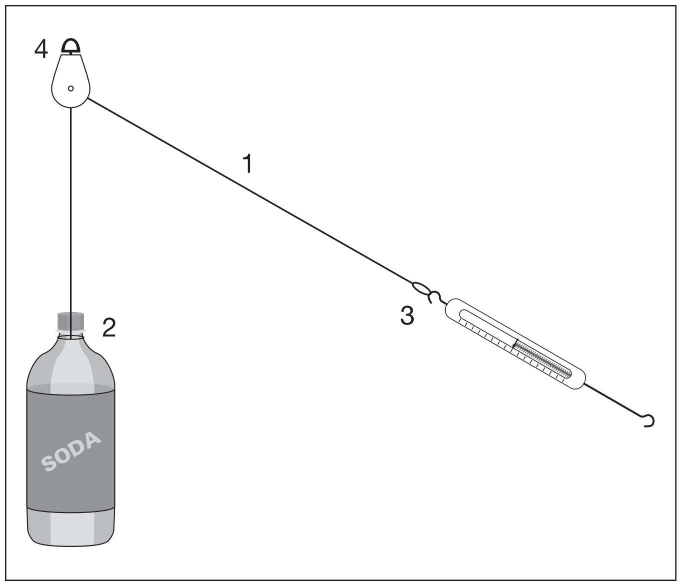
Study the diagrams as you read the written directions.

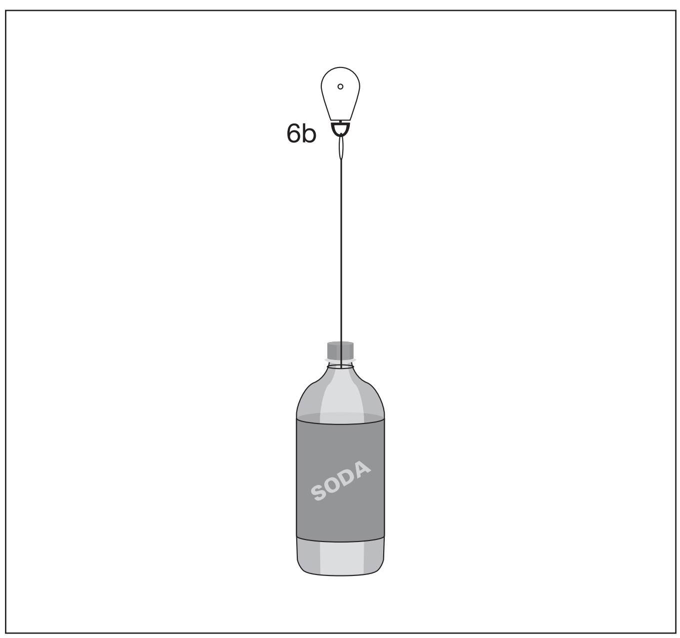
Materials

- Bottle (2–liter plastic; filled with tap water) — *one*
- Pulley (1–inch **single**) — *one*
- Pulley (1–inch **double**) — *one*
- Ruler (12–inch or 30–cm) — *one*
- Scissors — *one*
- Spring scale — *one*
- Twine (6–foot section) — *one*

Procedure

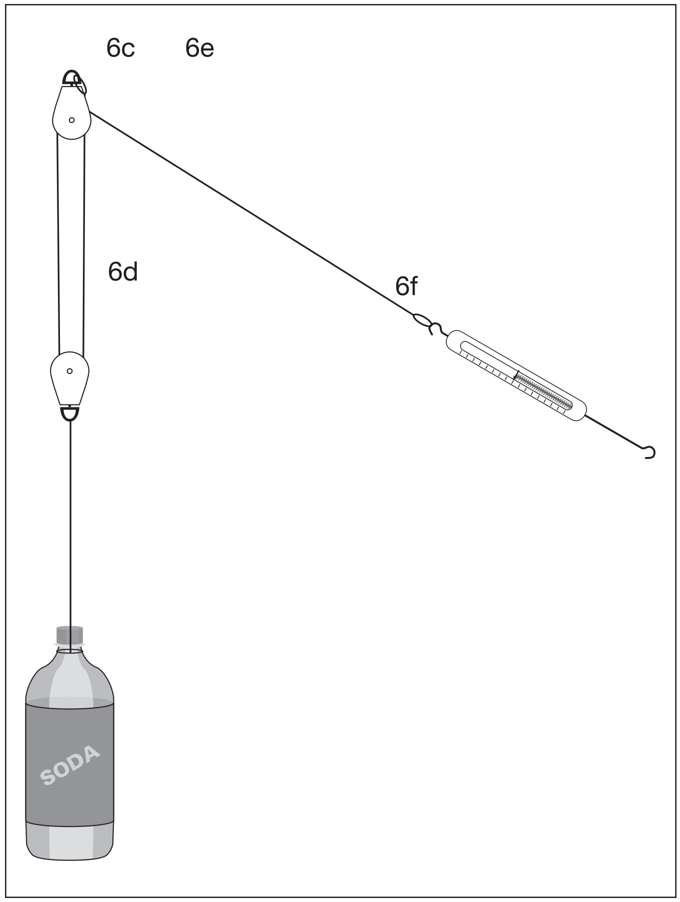
1. Run the 6–foot section of twine through the 1–inch **single** pulley.
2. Tie one end of the twine around the neck of the 2–liter bottle.
3. Make a simple loop on the opposite side of the 6–foot section of twine to secure the spring scale.
4. One member holds the pulley while another member pulls on the spring scale to lift the two-liter plastic bottle.
5. On the **Pulley Data** page, record the amount of force required to lift the plastic bottle (look at the spring scale for this information).





PULLEY EXPERIMENT (2)

6. Assemble a two-pulley system by following these steps and referring to the diagram.
   a. Using the ruler and scissors, *measure and cut* a 1–foot section from your original six feet of twine.
   b. Take the 1–inch **single** pulley and tie the 1–foot section of twine to the pulley hook or loop so that is it upside down. Tie the other end to the neck of the 2–liter bottle.
   c. Hold the 1–inch **double** pulley about one foot above the **single** pulley (already attached to the bottle).
   d. Run the 5–foot section of twine through *one* of the 1–inch **double** pulleys. Then run it down through the 1–inch **single** pulley and back up through the other pulley on the 1–inch **double** pulley.
   e. Tie one end of the 5–foot section of twine to the double pulley hook or loop.
   f. Tie a loop in the other end of the 5–foot section of twine and attach it to the spring scale.



7. One member holds the **double** pulley while another member pulls on the spring scale to lift the 2–liter plastic bottle.

8. On the **Pulley Data** page, record the amount of force required to lift the plastic bottle using the two-pulley system (look at the spring scale for this information).

9. Indicate to your teacher when you have finished this experiment.

PULLEY DATA

Record the amount of force required to lift the plastic bottle. (Look at the spring scale for this information.)

		AMOUNT OF FORCE
PULLEY SYSTEMS	ONE-PULLEY SYSTEM	
	TWO-PULLEY SYSTEM	

Draw a diagram of the pulley system that lifted the bottle with the least amount of force.

T.E.A.M. ACTIVITY 6

Cut this sheet into strips along dotted lines. Give each team member a different strip.

T.E.A.M. Activity 6

6a. This simple machine makes use of another simple machine—the inclined plane.

A spiral staircase is an enlarged version of this machine.

T.E.A.M. Activity 6

6b. This machine is an inclined plane that is wrapped around a central post in a spiral.

An example of this simple machine is a bolt and nut.

T.E.A.M. Activity 6

6c. This machine works by moving resistance up the spiral a short distance while it rotates the resistance around the spiral a long distance.

The auger is an example of this simple machine.

T.E.A.M. Activity 6

6d. This machine is useful because it pulls together objects and holds them together much tighter than they could be held without this machine.

Drilling tools make use of this simple machine.

T.E.A.M. Activity 6

6e. This machine opens and closes almost all vises.

This machine allows considerable force to be applied without much effort.

T.E.A.M. Activity 6

6f. When this simple machine is in the form of a propeller, it can help a boat or an airplane move.

This machine is very useful in situations in which precise measurement is required such as when a car's alignment needs to be adjusted. This is because very precise lateral movement is produced when rotational motion is used in this machine.

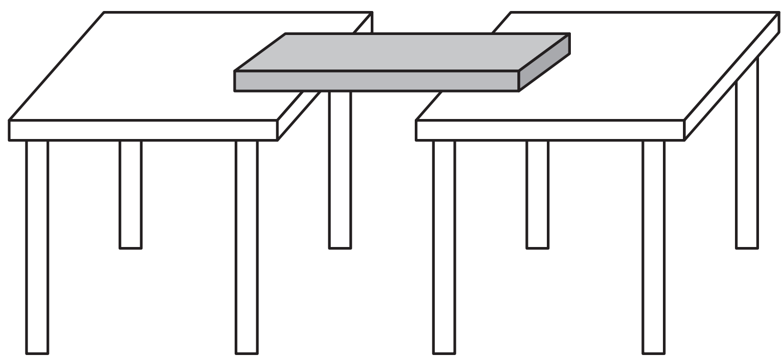
SCREW EXPERIMENT

Study the diagram as you read the written directions.

Materials
- Desks or Tables — *two*
- Screwdriver — *one*
- Screws — *six*
- Wood — *one*

Procedure
1. Look at the different screws that your teacher handed out to your group. Together with the class, agree on a number and description (size of screw and thread spacing) for each screw. Complete the *Size of Screw* and *Thread Spacing* columns of **Screw Data**.

2. Place your wood between two desks as shown below:



   You are placing the wood in this position so that if a screw goes through the wood, it will not damage a desk.

3. Using your screwdriver, screw each screw into the piece of wood. (**HINT** If you have difficulty getting the screw started in the wood, push on the top of the screw just until it sticks in the wood and then start using the screwdriver.) Since everyone in the group needs to feel how difficult it is to drive each screw into the wood, be sure that each member of the group has the opportunity to turn each screw with the screwdriver before it has gone all the way into the wood.

4. Complete your **Screw Data** page and indicate to your teacher when you have finished this experiment.

SCREW DATA

Rate the size of each screw: **short (1)** **medium (2)** **long (3)**

Rate the thread spacing: **fine** or **coarse**

Rate each screw from: **easiest to screw in wood (1)** to **hardest to screw in wood (6)**

	CHART OF DIFFERENT SCREWS		
SCREW NUMBER	SIZE OF SCREW	THREAD SPACING	EASE INTO WOOD
6			
5			
4			
3			
2			
1			

SCREW GRAPH

MYSTERIOUS MACHINE

Size of Screw

Rating						
Long (3)						
Medium (2)						
Short (1)						
Screw Number	1	2	3	4	5	6

Thread Spacing

Rating						
Coarse						
Fine						
Screw Number	1	2	3	4	5	6

Ease into Wood

Ratings						
Hardest (6)						
5						
4						
3						
2						
Easiest (1)						
Screw Number	1	2	3	4	5	6

TEAM MACHINE

You have studied six simple machines. You know that these machines are all around us. You also know that all complex machines include one or more of these six simple machines. Now you have the chance to apply what you know to create your own Team Machine.

Team Machine Requirements

1. Your Team Machine must move a weight (a roll of pennies) a distance of three feet.
2. Include at least two of the six simple machines in your Team Machine.
   a. Your team will choose which of the two simple machines to use.
   b. You may include more than two simple machines.
3. Your Team Machine may include more than one part. For example, your Team Machine may include a part that carries the weight three feet and a part that launches the carrier.

Good luck as your team designs your own special Team Machine. Remember that this is not a competition. Every team in your class can design a successful Team Machine.

Team Machine and the Scientific Method

Use the Scientific Method as you brainstorm, develop, and experiment with ideas for your Team Machine. Continue to act as scientists. Keep notes in your Science Journal:

1. Record the date for each entry.
2. Follow the steps outlined in the Scientific Method:
   a. State the problem/question.
   b. Write the hypothesis. (Write down group-generated ideas for your Team Machine.)
   c. Describe every experiment.
   d. Write down everything that you observe (data).
   e. Draw diagrams of the Team Machine ideas.
   f. Write any questions and/or solutions you may think of as you conduct your experiments.
   g. Document your conclusions

Important Notes

Remember that a scientist is a detective. Being a good detective involves keeping good notes!

1. Use the Scientific Method.
2. Document your hypotheses, experiments, and data.
3. Remember that experiments do not always work the way that the scientists want them to work.
4. Scientists who keep good records learn from every experiment, not just the experiments that work according to their hypotheses.
5. No experiment is a failure if the scientist keeps accurate records.

MACHINE DAY INSTRUCTIONS (1)

Introduction

In a few days your class will host a *Machine Day*. On *Machine Day*, your team will:

1. **Display** information describing one of the six simple machines and your Team Machine.
2. **Explain** the function of the simple machine you display and explain how your team used the scientific method to develop your Team Machine.
3. **Demonstrate** your Team Machine.

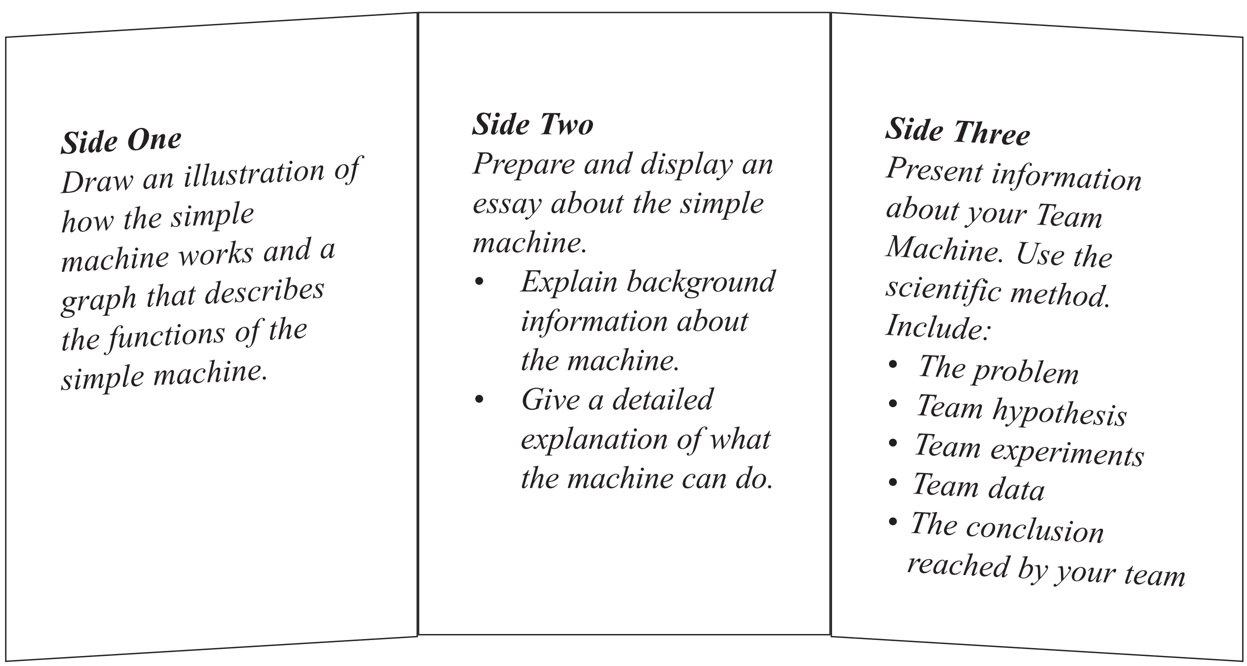
Part 1 Display

What your team must do:

Display what you have learned while studying Mysterious Machine.

Display Board Prepare a three-part Display Board that accomplishes two tasks:

1. Educate *Machine Day* visitors about one of the six simple machines.
2. Explain how your team used the scientific method to develop your Team Machine.



The display board should be eye-catching. It should quickly capture the viewer's attention and it must be neat and attractive.

Display Objects Display at least three objects that use the simple machine in completing their functions.

MACHINE DAY INSTRUCTIONS (2)

Part 2 Explain

What your team must do:

Prepare at least two team members to make oral presentations on *Machine Day*.

Explain a Simple Machine At least one person on your team must be able to answer questions about the simple machine in your Display.

1. Explain its history.
2. Explain how it functions.
3. Explain how we use this machine in our every-day lives.

Explain your Team Machine At least one person on your team must be able to explain how your team used the scientific method to develop your Team Machine.

1. Explain how your team defined the problem and came up with hypotheses.
2. Explain your team's experiments and your data.
3. Explain your team's conclusions and your final solution (your Team Machine).
4. Practice answering questions and making your explanations before *Machine Day*.

Part 3 Demonstrate

What your team must do:

Show *Machine Day* visitors how your Team Machine works.

Demonstrate your Team Machine At least one person on your team must give the demonstration.

1. Your Team Machine must move a weight (a roll of pennies) a distance of three feet.
2. You will have two attempts to demonstrate your Team Machine.

Roles and Responsibilities

Your team has a lot of work to do to prepare for *Machine Day*. Each student will have a specific role. Decide how your team will divide the roles and responsibilities. The roles are as follows:

1. **Project Director (one student)** — oversee all team *Machine Day* preparations
   a. Supervise all team members as they complete their responsibilities.
   b. Prepare and present an oral presentation explaining how the team used the scientific method to develop your Team Machine.
2. **Simple Machine Experts (two students)** — prepare the simple machine display (Consult your Science Journals and Group Folder.)
   a. Prepare *two* sides of the display board.
      - Illustrate the simple machine in action and provide a graph showing how the machine works. Use data from your team experiments during the simulation.
      - Write an essay providing background information about the machine and describe in detail what the machine can do.
   b. Display at least three objects that use the simple machine in completing their functions.
   c. Answer questions about the simple machine on *Machine Day*.
3. **Team Machine Experts (two students)** — prepare your Team Machine display and demonstration
   a. Prepare *one* side of display board.
      - Write an explanation of how your team used the scientific method to develop your Team Machine. Include dates, notes, and experimental data.
   b. Demonstrate your Team Machine.

Machine Rubric

Level 4 — *Exemplary*

- Your machine incorporates more than two simple machines in its design.
- Your machine moves a weight (roll of pennies) at least three feet.
- Your machine presentation demonstrates a thorough, well-developed understanding of concepts learned.
- You worked exceptionally well as a team.

Level 3 — *Expected*

- Your machine incorporates at least two simple machines in its design.
- Your machine moves a weight (roll of pennies) at least three feet.
- Your machine presentation demonstrates an accurate understanding of concepts learned.
- You worked well as a team.

Level 2 — *Nearly There*

- Your machine incorporates one to two simple machines in its design.
- Your machine moves a weight (roll of pennies) less than three feet.
- Your machine presentation demonstrates a limited understanding of concepts learned.
- You teamwork was limited.

Level 1 — *Incomplete*

- Your machine does not incorporate two simple machines in its design.
- Your machine moves a weight (roll of pennies) less than three feet.
- Your machine presentation demonstrates a minimal understanding of concepts learned.
- You do not work well as a team.

Machine Rubric

Level 4 — *Exemplary*

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DISPLAY RUBRIC

Level 4 — *Exemplary*

- Your display includes the necessary components:
  - — Display board with illustrations, graphs, essay, and information on Team Machine development
  - — Three objects
  - — At least one team member to present information
- Your display demonstrates a thorough, well-developed understanding of concepts learned.
- Your display is exceptionally neat, attractive, and eye-catching.
- Your written work consistently uses proper mechanics—paragraph form, sentence structure, grammar, punctuation, spelling, and capitalization.

Level 3 — *Expected*

- Your display includes the necessary components:
  - — Display board with illustrations, graphs, essay, and information on Team Machine development
  - — Three objects
  - — At least one team member to present information
- Your display demonstrates a general, adequately-developed understanding of concepts learned.
- Your display is neat, attractive, and eye-catching.
- Your written work uses proper mechanics—paragraph form, sentence structure, grammar, punctuation, spelling, and capitalization.

Level 2 — *Nearly There*

- Your display is missing some of the necessary components:
  - — Display board with illustrations, graphs, essay, and information on Team Machine development
  - — Three objects
  - — At least one team member to present information
- Your display demonstrates a limited, partially-developed understanding of concepts learned.
- Your display is missing many eye-catching and/or attractive details.
- Your written work sometimes uses proper mechanics—paragraph form, sentence structure, grammar, punctuation, spelling, and capitalization.

Level 1 — *Incomplete*

- Your display includes few of the necessary components:
  - — Display board with illustrations, graphs, essay, and information on Team Machine development
  - — Three objects
  - — At least one team member to present information
- Your display demonstrates a minimal, undeveloped understanding of concepts learned.
- Your display is not neat.
- Your written work does not use proper mechanics—paragraph form, sentence structure, grammar, punctuation, spelling, and capitalization.

ESSAY RUBRIC

Essay Rubric

Level 4 — *Exemplary*
- Your essay demonstrates a thorough, well-developed understanding of concepts learned.
- You use ample details to clearly support statements and/or conclusions.
- You consistently use proper mechanics—paragraph form, sentence structure, grammar, punctuation, spelling, and capitalization.

Level 3 — *Expected*
- Your essay demonstrates a general, adequately-developed understanding of concepts learned.
- You use some details to support statements and/or conclusions.
- You use proper mechanics—paragraph form, sentence structure, grammar, punctuation, spelling, and capitalization.

Level 2 — *Nearly There*
- Your essay demonstrates a limited, partially-developed understanding of concepts learned.
- You used few details to support statements and/or conclusions.
- You sometimes use proper mechanics—paragraph form, sentence structure, grammar, punctuation, spelling, and capitalization.

Level 1 — *Incomplete*
- Your essay demonstrates a minimal, undeveloped understanding of concepts learned.
- You used no details to support statements and/or conclusions.
- You do not use proper mechanics—paragraph form, sentence structure, grammar, punctuation, spelling, and capitalization.

Essay Rubric

Level 4 — *Exemplary*
- Your essay demonstrates a thorough, well-developed understanding of concepts learned.
- You use ample details to clearly support statements and/or conclusions.
- You consistently use proper mechanics—paragraph form, sentence structure, grammar, punctuation, spelling, and capitalization.

Level 3 — *Expected*
- Your essay demonstrates a general, adequately-developed understanding of concepts learned.
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- You use proper mechanics—paragraph form, sentence structure, grammar, punctuation, spelling, and capitalization.

Level 2 — *Nearly There*
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- You do not use proper mechanics—paragraph form, sentence structure, grammar, punctuation, spelling, and capitalization.

CONGRATULATIONS!

YOUR TEAM MACHINE
MOVED THE WEIGHT AT LEAST THREE FEET!

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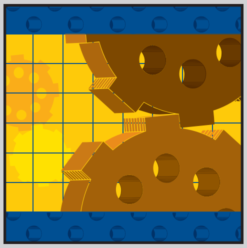

MYSTERIOUS MACHINE

STUDENT GUIDE

This letter introduces a mystery for your class. In order to solve the mystery you will need to learn how machines work and what they do.

Dear students,

We need your help. Our great, great-aunt Michelle Gear recently passed away. For over 60 years Aunt Michelle was an inventor. She spent half her life tinkering in her workshop. She designed and built wonderful machines. She helped many people with her ideas and inventions.

While she was working on a project she was very secretive. She never told anyone what she was working on. She would spend days and days in her workshop, then come out with her newest fabulous invention. She would invite everyone into her workshop. She would show us what she had built and describe everything that she had done.

While going through her workshop last week we discovered a diagram of a machine designed by Aunt Michelle. We have no idea what this machine is or how it can be used. We think that the diagram is complete, but we cannot find a model. We have studied all of her science journals, but can find no notes about this diagram or this idea.

The lack of notes is very unusual because Aunt Michelle was a very careful scientist. She kept meticulous notes about her ideas. She has dozens of science journals in her library. In these science journals she describes every invention she ever made. However, we can find nothing about this diagram.

Do you think that you can help us discover what this diagram is or what the machine can do? We considered asking a mechanical engineer, but thought that might be too expensive. Perhaps your class can use your brain power to solve this mystery for us?

Please let us know as soon as possible if you can help us.

Thank you,

The Gears

Gary and Gladys Gear

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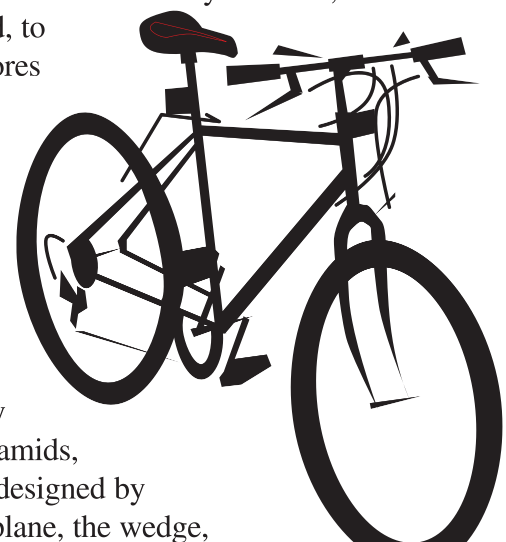
Learn Through Experience

Machines Are Everywhere

Machines are all around us. Think of the things you normally do every day. How did you get to school this morning? Did you arrive by bus, car, bicycle, or roller blades? If so, a machine helped you get to school. A machine made the clothes you are wearing. Before the food you ate for breakfast arrived on your table, machines were involved. For example, machines are used to plant and harvest the food, to process food, and to move the food from the farm or processing plants to stores where people buy it. Even in your school, machines are everywhere! The paper you write on, the pencils and crayons you write with, even the pencil sharpener in the room were created with a machine.

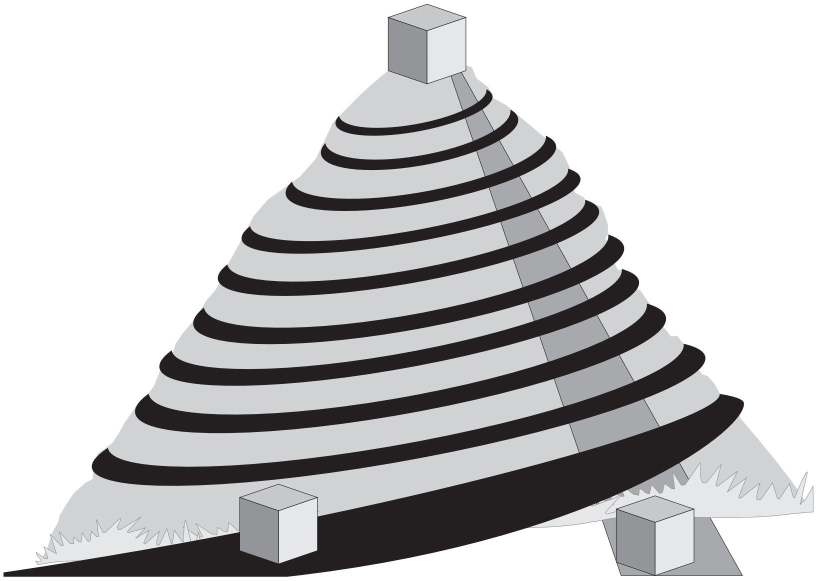


Simple and Complex Machines

What exactly is a machine? *A machine is a mechanical device that makes work easier*. Machines may be as complex as computers or space shuttles. They may be so basic that we do not recognize that they are machines. We call these basic machines *simple machines*. Simple machine designs are very ancient. Simple machines made it possible for our ancestors to build the pyramids, Stonehenge, and great cathedrals. Simple machines were the first machines designed by people to make their work easier. The six simple machines are the inclined plane, the wedge, the screw, the lever, the wheel and axle, and the pulley. The most complex machines usually use one or more of these simple machines. Even though they are called simple machines, it is not always simple to understand how they work.

Defining Work

All machines (both simple and complex) help us do work. What exactly do we mean by *work*? Students often say they work very hard when they are studying for a test. Scientists (also called *physicists*) who study machines have a very different meaning for the word *work*. To a physicist, *work happens when a force moves an object*. Think about this for a moment. If you were to push against the wall as hard as you could, you could not move it. Since you did not move the wall, a physicist would say that you had not done any work. To a physicist, work is done only when a force moves an object.



Understanding Work

Physicists developed an easy way (a formula) to define work: *Work = Force x Distance*. An example will explain how to use this formula. Imagine you have to move a heavy box to the top of a mountain. How much work will this task take? The amount of *work* depends on the *force* (effort) needed to move the box and the *distance* you must move the box. If you take a long, winding slope up the mountain, the distance you travel will be great, but you will move the box with little force. If you take the shortest distance up the mountain (straight up the steep side), you will need a great amount of force to move the box. You will accomplish the same amount of work (you move the box to the top of the mountain) no matter which path you travel.

Energy Powers Machines
The Law of Conservation of Energy states:

- The amount of energy in the universe is always the same.
- Energy cannot be created or destroyed (except for nuclear energy).
- Energy can change from one form to another.

The *Law of Conservation of Energy* is not about saving energy. It explains what happens when we use energy to power machines:

- A machine cannot put out more energy than the energy put into it.
- Machines can move energy from place to place.
- Machines cannot create energy (not even power plants).
- Machines can convert energy from one form to another.

A formula to describe the law of conservation of energy is *Work In = Work Out*.

Force
In simplest terms *force* is a *push* or a *pull*. Force causes a machine to work. Nothing will move without the use of force. Force can affect an object in many different ways.

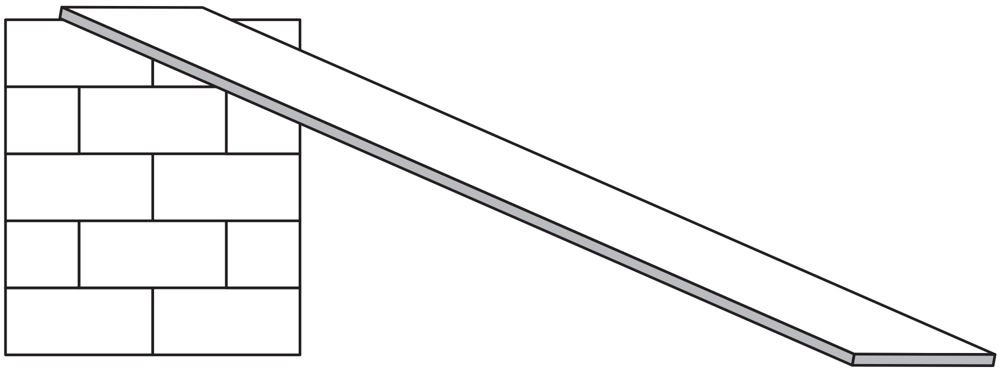
- Force can make a moving object change direction. An example is when a baseball player hits a pitched baseball. The force of the bat changes the direction of the baseball.
- Force can make something that is moving stop. An example is when a catcher stops the motion of a baseball that the pitcher has thrown.
- Force can make an object at rest begin to move. An example is when the pitcher throws the ball from the pitcher's mound towards the batter.
- Force can change the shape of an object. An example is when you squeeze (apply force to) soft clay to make a shape.

Friction
Friction occurs when two objects touch one another. It is a force that affects machines. Even surfaces that appear very smooth actually have tiny bumps and hollows. When two surfaces touch, the bumps and hollows stick together. This sticking is called friction. It slows down movement in the machine. It also converts some of the energy put into the machine to heat energy or sound energy. The machine is less efficient. Machine designers (called engineers) try to reduce friction when they design machines. They use hard, smooth materials. They also use lubricants. Lubricants fill in the surface bumps and hollows. We use oil, wax, grease, and soap as lubricants. Smooth materials and lubricants can decrease friction, but cannot get rid of it. Friction wastes some of the energy that powers a machine.

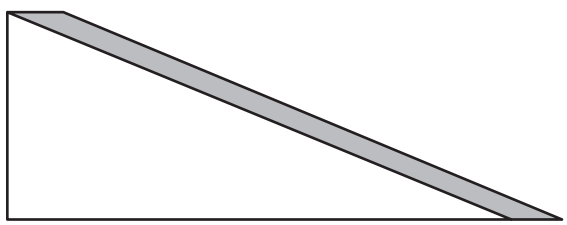
Making Use of Friction
Sometimes friction is not a problem. Some machines work *because of* friction. Car or bicycle tires depend on friction to grip the road. Without friction, the tires would simply spin around and your car or bike would not move at all. That is why oil and ice on the road are dangerous. They reduce the friction that keeps the tires turning. Other common tools also use friction. The eraser on your pencil removes marks because of friction. Sandpaper removes paint or smooths surfaces because of friction.

Six Simple Machines
You are about to learn about six simple machines. You will study what they do and how they work. Remember, they were people's first attempts to make their work easier. Even the most complex machines today are made up of one or more of these six simple machines. Use everything you know about machines, work, and friction as you study Michelle Gear's mysterious invention.

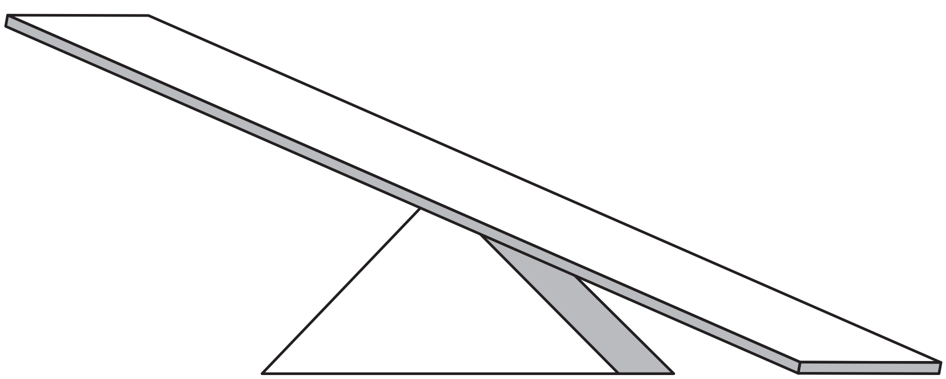
SIX SIMPLE



Inclined Plane

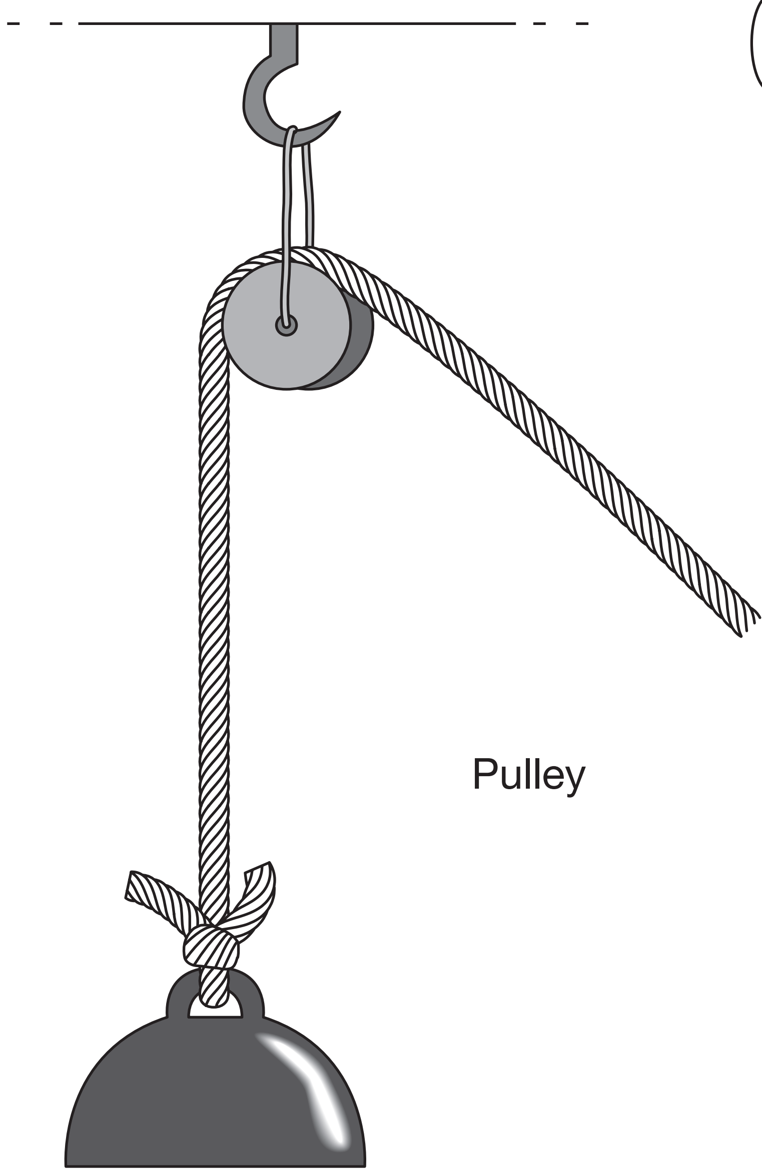


Wedge

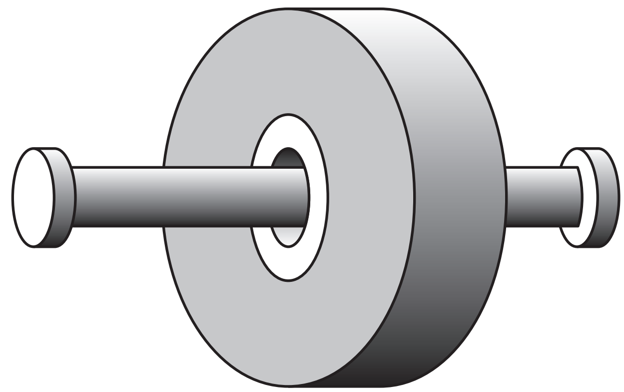


Lever

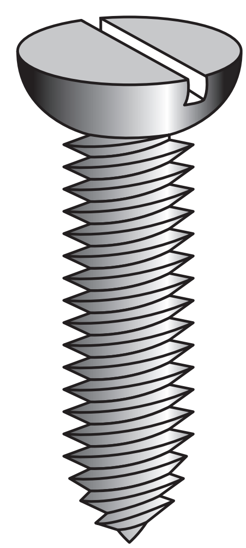
MACHINES



Pulley



Wheel and Axle



Screw

A Scientist is a Detective

Scientists work just like police detectives.

- They both try to **find the answer** to a mystery or problem.
- They both ask **questions** to figure out what they need to know.
- They both develop **theories** to give possible answers (or solutions).
- They both keep careful records of everything they learn (**observe**).
- They both use what they learn (clues) to figure out a **reasonable solution** to their mystery or problem.

Detectives keep their questions, theories, and observations in notebooks. Scientists keep journals. Learn how to keep and use an authentic science journal.

Keep an Authentic Science Journal

1. **Dates**
   Record the date every time you write down a fact, theory, or observation.
2. **Complete Descriptions**
   Write down every fact and describe every experiment. Write down everything you observe. Be so detailed that someone who knows nothing about machines will understand everything in your journal.
3. **Illustrations**
   Draw diagrams of your experiments. Show how the six simple machines work. You do not have to be a great artist. Use simple sketches. These illustrations will help you remember exactly what you did. They will also help someone else understand your Science Journal. Scientists often take pictures at different points in their experiments. If you have a camera, you may also take pictures of your experiments.
4. **Important Questions**
   As you conduct your experiments, you may think of questions that you do not understand. Write any questions in your Science Journal. These questions will help you decide how to conduct more research. The answers to the questions may provide more clues to help solve the mystery.
5. **Possible Solutions**
   As you conduct your experiments, you may think you have the solution to the mystery. Write down this possible solution (also called a theory). A theory is a valuable tool when you are trying to solve a mystery.

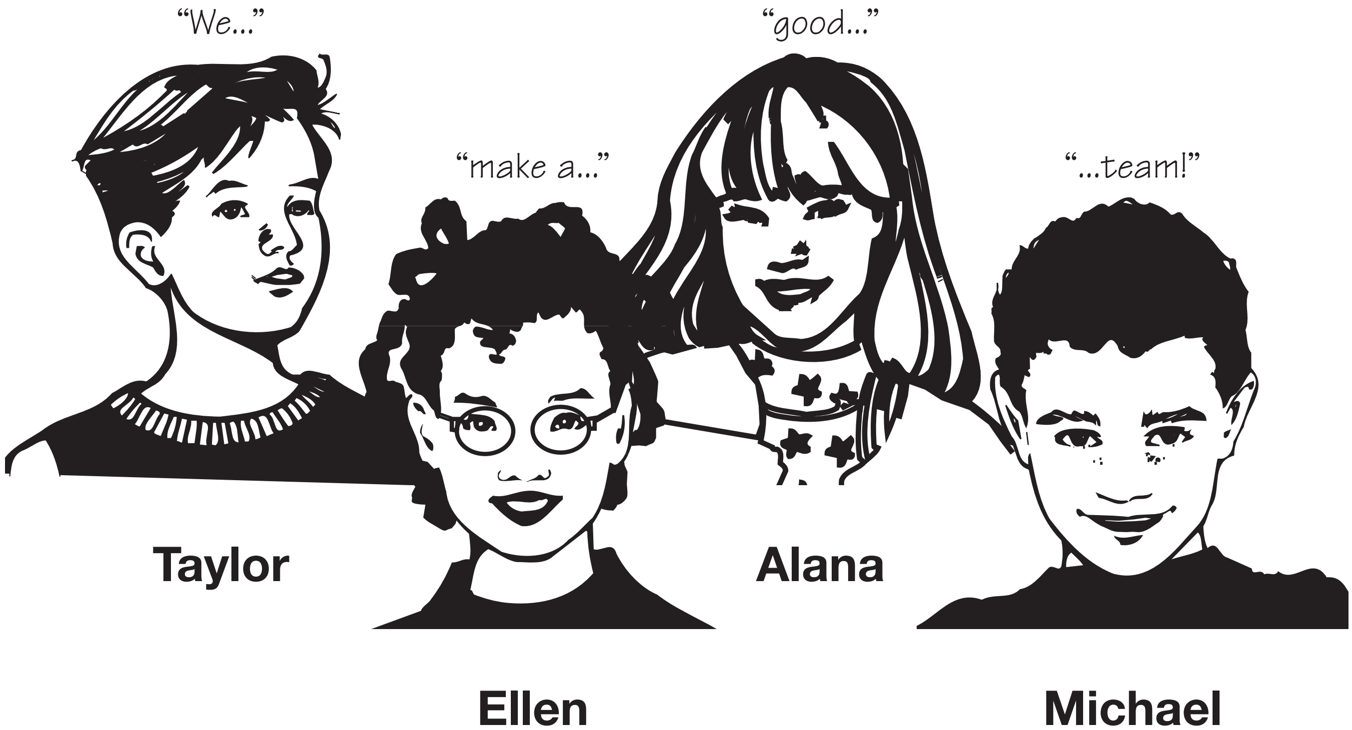
Good Luck

Your task is to solve the problem of Michelle Gear's *Mysterious Machine*. Learn about the six simple machines. Ask questions. Develop theories. Make observations. Record everything in your Science Journal. Every day study your Science Journal for clues. Use what you learn to develop a reasonable solution to the problem.

What are T.E.A.M. Activities?

T.E.A.M. stands for ***T**ogether **E**veryone **A**ccomplishes **M**ore*. Each T.E.A.M. Activity provides important information. This information is in the form of clues. Your team members share these clues with each other. Your team works together to solve a problem using all of the clues. You will discover two things:

1. Every member of your team has something to offer.
2. Many brains working together can solve a problem.



How do you do T.E.A.M. Activities?

1. Your team's goal is to solve the problem presented to your group.
2. Each team member receives some special information (clues to solve the mystery). No one else on your team has those same clues.
3. Each team member will share his or her clues only one way—orally.
4. Each team member will need all the clues to solve the problem.
5. No one may read or look at another team member's clues.
6. Each team member will participate!
   (Of course, you may repeat clues if needed. Remember that you must share clues orally.)
7. Once all members have individually shared their clues, each team member should continue to contribute to the team effort of solving the activity.
8. Each team member will take a turn to talk and give ideas or opinions.
9. Practice the most important skill for a successful team—listening! We can all learn from each other. Listen carefully while other team members talk.

Good luck on your **T.E.A.M. Activities**! You will enjoy uncovering the clues each day. Put the clues together to learn about a simple machine. Use what you learn to solve the mystery of Michelle Gear's machine.

MYSTERIOUS MACHINE DIAGRAM OR MODEL