Advanced Manufacturing and Materials

**Playground Project**

Grade Levels: 6th grade

Academic Content Areas: Science, Technology, Engineering and Mathematics

Topics: Numbers, Numbers Sense and Operations; Measurement; Mathematical processes; Science and Technology; Scientific Ways of Knowing

- Recommended area of co-teaching for an AFRL Engineer or Scientist

**Main Problem/Essential Question**

How can your knowledge of geometry help you create a safer playground?

**Summary**

In this lesson, students work in small groups to design, plan and create a three-dimensional model of a safe playground. Students will conduct research to determine the specific needs for the playground and design and draw a scale model of their playground which must include a slide, climbing structure, swing set, and at least one other piece of equipment. Students will also calculate the perimeter for fencing needs and the volume of rubber mulch needed to safely cover their playground. They will also determine the total cost based on the materials needed. The culminating event is a presentation for which each group will make a three-dimensional model of their design.

**Big Ideas / Focus**

Students will research their chosen pieces of equipment for their playground to determine safe fall zone perimeters. Students will use this knowledge to design their playground; estimate the perimeter of their playground, the volume of needed rubber mulch, and determine the area of space each individual piece of equipment will require. After students design a playground on graphing paper that reflects these parameters, students will then build a representative model of their design using their created diagram.

**Prerequisite Knowledge**

- Four basic math operations with whole numbers and decimals
- Data collection and analysis
- Use of geometric formulas for area, perimeter and circumference
- Ratio and proportion for scale drawings
- Basic computer skills
Standards Connections

Content Area: Mathematics

Number, Number Sense, and Operation Standard
Students demonstrate number sense, including an understanding of number systems and operations and how they relate to one another. Students compute fluently and make reasonable estimates using paper and pencil, technology-supported and mental methods.

6th grade- Benchmark D: Use models and pictures to relate concepts of ratio, proportion and percent.

14. Use proportional reasoning, ratios and percents to represent problem situations and determine the reasonableness of solutions.

Measurement Standard
Students estimate and measure to a required degree of accuracy and precision by selecting and using appropriate units, tools and technologies.

6th grade- Benchmark C: Identify appropriate tools and apply appropriate techniques for measuring angles, perimeter or circumference and area of triangles, quadrilaterals, circles and composite shapes, and surface area and volume of prisms and cylinders.

3. Estimate perimeter or circumference and area for circles, triangles and quadrilaterals, and surface area and volume for prisms and cylinders by: a. estimating lengths using string or links, areas using tiles or grid, and volumes using cubes; and b. measuring attributes (diameter, side lengths, or heights) and using established formulas for circles, triangles, rectangles, parallelograms and rectangular prisms.

6th grade- Benchmark E: Use problem solving techniques and technology as needed to solve problems involving length, weight, perimeter, area, volume, time and temperature.

4. Determine which measure (perimeter, area, surface area, volume) matches the context for a problem situation; e.g., perimeter is the context for fencing a garden, surface area is the context for painting a room.

Mathematical Processes
Students use mathematical processes and knowledge to solve problems. Students apply problem-solving and decision-making techniques, and communicate mathematical ideas.

5th-7th grade- Benchmark- A: Clarify problem-solving situation and identify potential solution processes; e.g., consider different strategies and approaches to a problem, restate problem from various perspectives.

5th-7th grade- Benchmark- B: Apply and adapt problem-solving strategies to solve a variety of problems, including unfamiliar and non-routine problem situations.

5th-7th grade- Benchmark- H: Use representations to organize and communicate mathematical thinking and problem solutions.

Science and Technology:
Students recognize that science and technology are interconnected and that using technology involves assessment of the benefits, risks and costs. Students should build scientific and technological knowledge, as well as the skill required to design and construct devices. In addition, they should develop the processes to solve problems and understand that problems may be solved in several ways.
6th grade- Benchmark B: Design a solution or product taking into account needs and constraints (e.g., cost, time, trade-offs, properties of materials, safety and aesthetics).

5. Design and build a product or create a solution to a problem given one constraint (e.g., limits of cost and time for design and production, supply of materials and environmental effects).

Scientific Ways of Knowing:
Students realize that the current body of scientific knowledge must be based on evidence, be predictive, logical, subject to modification and limited to the natural world. This includes demonstrating an understanding that scientific knowledge grows and advances as new evidence is discovered to support or modify existing theories, as well as to encourage the development of new theories. Students are able to reflect on ethical scientific practices and demonstrate an understanding of how the current body of scientific knowledge reflects the historical and cultural contributions of women and men who provide us with a more reliable and comprehensive understanding of the natural world.

6th grade Benchmark C: Give examples of how thinking scientifically is helpful in daily life.

3. Identify ways scientific thinking is helpful in a variety of everyday settings.

Preparation for activity
Prepare copies of instructions and rubric for student use.
Collect materials
If appropriate: bookmark Internet sites for student research.

Critical Vocabulary
Area – the amount of space inside the boundary of flat (2-dimensional) objects such as a triangle or circle
Diagram – a geometric figure including measurements, used to illustrate a mathematical statement
Fall zone – minimum area requiring safe surfacing that extends beyond the ground footprint of the equipment
Perimeter – the distance around a two-dimensional shape
Scale model – a model that shows a real object with accurate sizes except they have all been reduced or enlarged by the same specific amount (called the scale)
Volume – the amount of three-dimensional space occupied by an object

Timeframe

<table>
<thead>
<tr>
<th>Day</th>
<th>Time Allotment</th>
<th>Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>50-60 minutes</td>
<td>Pre-test; Introduction; form groups; group brainstorming</td>
</tr>
<tr>
<td>2</td>
<td>50-60 minutes</td>
<td>Group research, including pricing</td>
</tr>
<tr>
<td>3</td>
<td>50-60 minutes</td>
<td>Create design; develop formula sheet</td>
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<tr>
<td></td>
<td>50-60 minutes</td>
<td>Cost analysis of playground</td>
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<tr>
<td>5</td>
<td>50-60 minutes</td>
<td>Build scale models</td>
</tr>
<tr>
<td>6</td>
<td>50-60 minutes</td>
<td>Finish scale models; write presentation</td>
</tr>
<tr>
<td>7</td>
<td>50-60 minutes</td>
<td>Group presentations; evaluations; post-test</td>
</tr>
<tr>
<td>8</td>
<td>30 minutes</td>
<td>Post-test</td>
</tr>
</tbody>
</table>

**Materials & Equipment**

Access to computers and the Internet

Science notebooks

Graph paper

A variety of materials can be collected for students to make their model including (but not limited to):

- Strips of balsa wood
- Craft sticks
- Toothpicks
- Straws
- Wooden dowels
- Tag board
- Various colors of paper
- Clay
- Glue
- Masking tape
- Scotch tape
- Scissors
- Rubber cement
- General art supplies

Recycled materials such as:

- paper towel tubes
- egg cartons
- cardboard
- thread spools
- plastic bottles
- milk jugs

Tools:

- class set of rulers
- scissors
- craft saw
- file/sand paper
Safety & Disposal
Proper use of saws, scissors, and file/sand paper should be reviewed.
Always have students wear safety glasses when sawing.
Always have an adult present when a student is using a saw.
Do not allow students to sniff rubber cement fumes.

Pre-Activity Discussion
Show the LabTV video entitled “Model Career” about the engineers who build scale models as prototypes for the Navy’s fleet. This can be followed by the LabTV video entitled “Real World Design Challenge” in which high school students compete by designing, constructing, and testing something that addresses today’s problems.
Open a discussion about a career field in which all they do is design and build models because the actual size is too cost prohibitive (refer to the first video, “Model Career”). Then discuss how the “Real World Design Challenge” in high school helps students learn how to design and build a model for testing, just like the engineers in the first video. Now they can do the same thing, design and build a scale model to solve a real-world problem: safety on playgrounds.
Lead the discussion to playgrounds, including:

• What are student’s favorite pieces of playground equipment?
• Elicit what students think is important when designing a playground.
  The goal is to lead the students to discuss safety. Elicit the dangers of playgrounds,
  (e.g. running into someone swinging, falling off the equipment, falling and scratching up
  knees and hands, etc.)
• Every year approximately 200,000 children are treated in hospital emergency rooms for
• Explore your school’s playground. Discuss what each piece of equipment does and
  who seems to use it.
  Example: Their playground has an area designed for smaller children and a ramp for
  wheel chair access. A student states that they see mostly girls on the swings and
  mostly boys on a climbing wall. Another individual points out that the climbing wall can
  only be used by one kid at a time while the teeter totter can be used by two. Another
  student may note that there are rubber mats under the swings and slide but wood mulch
  under the teeter totter. Lastly, a student notes that there is a fence around the edge to
  keep students away from the roads and safe while they play.

Teacher Instructions
Post student roles in a visible location for duration of the lesson, (located in the Student
Roles Section of this document).

Day 1:
Objective: Students will determine that playgrounds are designed to meet a variety of
needs and interests for different age groups as well as to ensure safety of playground
users. Students will identify the structures they will be including in their playground.

1. Pre-test
2. Discuss:

- Engineering challenge: students are to design a new playground for their school, which is safe and fun. Groups will design a safe playground using their mathematical skills and their choice of equipment.
- Each group will research equipment, choose equipment, design a playground, and build a scale model. Students will need to use math to calculate safe distances to place equipment, determine area of their playground, the perimeter of the playground for fencing needs and the volume of mulch needed to safely cover their playground.
- Design parameters:
  - Each playground must include 4 structures (a slide, climbing structure, swing set, and at least one other piece of equipment).
  - The playground cannot have an area of more than 5,000 ft²
  - Include a fence around the perimeter of the area of the playground.
  - You can get extra points by applying good citizen thinking and make sure that your playground is handicapped accessible and useable.

2. Place students into groups of 3-4.

3. Have student teams use science notebooks to brainstorm 3 ideas that can help make a playground safer (lighting for after dark, rubber mulch, rubber mats, more space between equipment, well marked edges, etc.).

4. Have student teams use science notebooks to brainstorm on two additional types of equipment they may want in their playground in addition to the slide, climbing structure, and swing set.

5. Have students share their ideas with the team and pick the one or two additional structures they want to research to possibly add to their playground.

6. Make sure students have an up-to-date list of the equipment they will be including, in their science notebook. (This list may also include lighting, ramps, etc.: based on the individual team’s interests and instruction you have provided).

Day 2:
Objective: Students will research each piece of equipment in order to identify cost, size, and fall zone; this information will be recorded in their science notebook. Students will also journal 3 ways to make a playground safer based on Internet research.

1. Inform students:
   - Teams will need to decide who will research which pieces of equipment.
   - Each student should research two pieces of equipment; this will provide each group with two types of each form of equipment to choose from when designing the team playground.
   - Students will need to record cost, size, and fall zone as well as print out a picture.
   - After students conduct the equipment research, they must each individually research 3 ways to make a playground safer. These 3 ideas must be documented in their science notebook. (It may be best to bookmark some of the suggested sites that contain this information to guide students in an effective/efficient research).
   - Suggested websites: provided in resources section.
2. Have student groups design a table for data collection of equipment type, size, fall zone, and cost. (Teacher should approve each group's table before allowing the group to start research).

3. Allow students to conduct Internet research.

4. Have student teams regroup for 5-10 minutes to organize their data so everyone has a complete table. Remind students to label the equipment images they printed out. Have students note that since they have two slides they have to figure out how to label the table and image so they do not get confused on which set of data matches which image.

Day 3:
Objective: Students will create a conceptual design for their playground including the 4 mandatory pieces of equipment. (Any additional items such as lighting and shrubbery must be included in this design.) Teams will also create a formula sheet that documents all formulas used to create the playground including finding the perimeter for fencing. (Depending on resources and student ability this may either be done via the Internet using Kid Cad software like that at http://www.childrenssoftwareonline.com/Default.aspx?m=item&pID=1700 or through the use of graph paper, scissors, and tape.)

An engineer from WPAFB could offer students assistance in their design process, including informational data on how scientists and engineers are concerned with areas, perimeters, and safe zones as further discussed in the career connections section.

Provide students with rubrics (Appendix C & D).

1. Discuss:
   Design parameters: (this should be posted in the classroom)
   a. Each playground must include 4 structures (a slide, climbing structure, swing set, and at least one other piece of equipment).
   b. The playground cannot have an area of more than 5,000ft^2
   c. Include a fence around the perimeter of the area of the playground.
   d. You can get extra points by applying good citizen thinking and make sure that your playground is handicapped accessible and useable.

Discuss that designs should: (this should be posted in the classroom)
   • Be drawn to scale (for example, 1/4 inch = 1 foot or 1 cm = 2 m) on grid/graph paper showing the placement of each piece of playground equipment and all additional items they want to include in their playground such as trees, flowers, benches, etc.
   • Indicate the fall zone by drawing a lightly shaded area the correct distance around the piece of equipment,

Discuss that students must create a formula sheet that includes all the formulas that they use and identify what they use each formula for (amount of sod, grass, fencing, pavement, etc.).

2. Allow students to begin design construction. (Remind students that design implementation may require multiple tries/redesigns in order for groups to meet design parameters and desired aesthetics.)
3. Homework:

Have student’s journal three ways that scientific thinking is helping them design this playground.

Inform students that on Day 5 they will be building their model playground. Students may bring in supplies to use in building their models; this may include Connects®, Legos®, Bendy sticks®, or other supplies they may want to use in building.

Day 4:
Objective: Students will use their design to calculate their playground cost. The final cost will be provided in a representative data table.

1. Discuss objective with students. Remind students that although they are working in a group, each student must construct a table and perform the necessary calculations in their science notebook.

2. Remind students that their table must include:
   - All 4 (or more) pieces of playground equipment
   - Any additional equipment including lights, trees, shrubs, benches, etc. (these costs should be established by the teacher)
   - Amount of fence needed (cost per foot should be established by the teacher)
   - Volume of mulch needed (teacher should explain that for this type of playground rubber mulch should be 4 inches thick for a 5-6 foot fall and 6 inches thick for a 12 foot fall. Students will need to determine the thickness based on their chosen equipment.
   - Students must calculate their total playground cost.

4. Allow students to create their own table and start cost calculations.
   - Remind students to refer to the formula sheet they created in Day 3 to help with their calculations.
   - Remind students that they recorded pricing in Day 2.
   - Provide assistance where needed.

5. Homework: Ask students to bring in supplies to use in building their models; this may include Connects®, Legos®, Bendy Sticks®, or other supplies they may want to use in building their playground.

Day 5:
Objective: Students will build an accurate scale model that represents the design created in Day 3; this model will include a key.

1. Introduce students to available supplies for their model building.

2. Review with students what a scale model means. Provide each student with a ruler and review an example of how to use a ruler to maintain a scale model.

3. Discuss as a class an appropriate scale for this activity such as 1 cm = 1 ft.

4. Allow students to construct their playground model using the design created in Day 3.

5. Remind groups that they must provide a key on their model to explain the scale.
Day 6:
Objective: Students will complete their model, if time is still needed. Students will create a 5-minute presentation to share with the class. This presentation must include a list of student engineers, a table that shows equipment: size, fall zone, cost, fence and perimeter, rubber mulch and amount as well as the total cost of the playground, and 5 ways to make a playground safer. *(Presentations may be done in PowerPoint)*

1. Discuss today’s objectives.
2. Discuss presentation requirements: (this should be posted in the classroom)
   a. Display a finished model of the group’s playground.
   b. A list of Student Engineers involved in this design.
   c. Discuss decisions the group made based on their research and reasoning.
   d. Display a table that shows:
      ✓ Equipment
      ✓ Equipment size
      ✓ Equipment fall zone
      ✓ Individual equipment cost
      ✓ Fence, perimeter size, and cost
      ✓ Rubber mulch, volume, and cost
      ✓ Total cost of the playground
   e. 5 ways to make a playground safer.
   f. Answer: How has your group’s research created a better recess environment?

Day 7:
Objective: Student groups will present their playground model. The presentation will be graded on the requirements provided in Day 6, using the rubric provided in Appendix D. *(Presentations may be done in PowerPoint)*

Inviting an engineer to listen to the groups’ presentations lends authenticity to the project.

1. Allow student groups to present for 5 minutes. Allow classmates to ask questions.
2. When all groups have completed their presentations:
   a. Discuss what students have learned, (examples may include: equipment cost, playground safety, how much planning goes into designing a playground, or how playgrounds can be made handicapped accessible)
   b. Discuss what skills they have used, (examples may include: how to calculate perimeter and area, how to build a scale model, how to work as a team, how to collect data in an organized manner, or how to share information)

Day 8:
Objective: Conduct post-test.

1. Administer post-test, Appendix A.

**Background Information**

In the US, a prospective cohort study found that playground injuries were more severe and had a higher admission rate than all other child injury mechanisms except transportation. More than 213,700 children are treated in US emergency departments annually for playground equipment injuries. Of these injuries, 35% are fractures and 75% of the children were injured by falling.
Three percent of playground injuries require admission to hospital, some 6,400 children per year, of whom 92% have fractures. Equipment falls have a 3.9 times greater odds of severe fracture compared with playground fractures from standing height falls. Major determinants of playground fall injury risk include fall height and surface area. (These statistics come from: http://www.plosmedicine.org/article/info:doi%2F10.1371%2Fjournal.pmed.1000195)

**Instructional tips**

- It is helpful to have photos of playgrounds to show students to generate more interest and provide visual ideas, before you start the brainstorming session (Refer to Appendix F).
- Bookmarking sites ahead of time for students to begin their research saves class time.
- Price guides can be developed using a variety of resources including Home Depot and Lowe’s Home Improvement.
- Price guides could be developed in Excel or using a Word table.
- Inviting an engineer to listen to the groups’ presentations lends authenticity to the project.

**Assignment of Student Roles and Responsibilities:**

*Students will all assume the same role:*

(This should be posted in the classroom throughout the lesson)

<table>
<thead>
<tr>
<th>Role Name</th>
<th>Brief Description</th>
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<tbody>
<tr>
<td>Civil Engineer</td>
<td>Responsible for working collaboratively with team members</td>
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<tr>
<td></td>
<td>Responsible for researching two pieces of playground equipment and recording</td>
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<tr>
<td></td>
<td>required information.</td>
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<td></td>
<td>Responsible for making a scaled 3-D model of a piece of their playground equipment.</td>
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<td></td>
<td>Responsible for helping their group make decisions.</td>
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<td></td>
<td>Responsible for making sure their team uses correct formulas.</td>
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<tr>
<td></td>
<td>Responsible for developing a presentation and correctly completing all parts of</td>
</tr>
<tr>
<td></td>
<td>this project.</td>
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<td></td>
<td>Responsible for maintaining an accurate science notebook.</td>
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</tbody>
</table>

**Student Instructions**

Student instructions are imbedded within teacher instructions.

Be sure to provide students with a copy of the grading rubrics (Appendix C and D).

**Formative Assessments**

This unit includes the assessments of a written pre-/post-test, a participation rubric, and a project rubric. Additionally it is recommended that science notebooks be assessed as well, this is discussed below.
Student’s progress and skills should be monitored through grading of their science notebook and formula sheet. Students should be graded on data recording, organization of data, and calculations.

Model design, finished model, and presentation should be graded using the attached rubrics. Rubric should be provided to students on Day 3. The participation rubric is Appendix C. The Playground Project rubric is Appendix D.

**Pre-Test / Post-Test**
Refer to Appendix A.

**Pre-Test / Post-Test Rubric**
Refer to Appendix B.

**Technology Connection**
The ADISC Model of technology created by ITEL:

<table>
<thead>
<tr>
<th>Integration Model</th>
<th>Application Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technology that supports students and teachers in <strong>adjusting, adapting, or augmenting</strong> teaching and learning to meet the needs of individual learners or groups of learners</td>
<td><a href="http://www.bgfl.org/bgfl/custom/resources_ftp/client_ftp/">http://www.bgfl.org/bgfl/custom/resources_ftp/client_ftp/</a> and ks2/maths/perimeter_and_area/index.html: Interactive website “Everything You Wanted to Know About Area and Perimeter”: for students who need to review area and perimeter</td>
</tr>
<tr>
<td>Technology that supports students and teachers in <strong>dealing effectively with data</strong>, including data management, manipulation, and display</td>
<td><a href="http://www.harcourtschool.com/activity/con_math/g04c24.html">http://www.harcourtschool.com/activity/con_math/g04c24.html</a>: Interactive website “Measurement Equivalents”: for students who need to review measurement equivalencies</td>
</tr>
</tbody>
</table>
| Technology that supports students and teachers in conducting **inquiry**, including the effective use of Internet research methods | Excel: may be used by teachers to develop a price guide or by students to organize data collection.  
PowerPoint: may be used by students to organize their presentation information.  
Calculator: may be used by students to check their math.  
Ruler: will be used by students to measure pieces of their design and model. |
| Internet for research of equipment and safety information.                         |                                                                                                                                                    |
Technology that supports students and teachers in **simulating** real world phenomena including the modeling of physical, social, economic, and mathematical relationships

Kid Cad: Teachers may have the students use computer drawing software to draw their designs.

Technology that supports students and teachers in **communicating and collaborating** including the effective use of multimedia tools and online collaboration

PowerPoint / Microsoft Word / Excel: students may use this software to enhance their presentation or data organization.

**Interdisciplinary Connection**

**Language Arts** - After completing this project, students could write persuasive letters to their principal, PTO, or school board expressing any safety concerns they have discovered about their school playground.

**Art** – Building the three-dimensional playgrounds could be an interdisciplinary project with the art specialist.

**Home Connection**

Students can examine playground equipment in their yard or neighborhood for safety. Students can record and sketch the equipment they see, measure dimensions and distance to surrounding objects (to determine if there is a safe fall zone).

Three-dimensional models can be constructed at home.

**Differentiated Instruction**

Scaffolding – some students or groups could be provided with a pricing guide rather than having students develop their own. Some students or groups might need a graphic organizer (Appendix E) to help them determine the total cost of their playground.

Students can research playgrounds for special needs students.

Students can interview younger students at the elementary school or conduct a survey at the elementary school. This could add some statistical analysis to the project. The teacher can require one member of each team to research special requirements for special needs students.

**Extension**

Students can research how to make their playground handicapped accessible.

As an additional activity, have the students try to maneuver a wheelchair or walker around their school playground or nearby park.

Students can research how to make the existing school playground safer or more accessible.

**Career Connection**

When designing new aircrafts Aerospace engineers are initially given size requirements that are set to ensure payloads such as tanks, helicopters, or mobile command stations will fit in the new design. These measurements are given in length, width, height, (volume), and weight. Engineers then design the new aircraft to ensure these military needs are met.
Designers will calculate the total volume capabilities of the plane so they can tell users how much equipment can be stored and where to store it in the cargo area.

Aircraft designers need to calculate the volume of fuel they can carry on the aircraft. Fuel is often carried in bladders that are stored in the cargo area of a plane for extended military flights. The size of the bladder is determined by the available cargo space. Proper bladder choice is based upon these calculations.

Aircraft designers, engineers, and technicians must be concerned with safety zones around testing and repair systems to ensure the safety of operators and bystanders. Engineers at the WPAFB Power and Propulsion directorate are concerned with these specifications whenever they are testing or evaluating an engine.

Air traffic controllers and flight deck personnel determine where to put all parked aircraft on the tarmac for loading, unloading, or storage. This is done by studying the plane size and needed area for plane accessibility. On a flight deck, operators must also be concerned with maintaining large enough runways for flight take off and wing span.

City planners pay special attention to survey information provided on their site. Using the provided mathematical data, city planners can best design the roadways, industrial areas, and common areas such as parks and playgrounds.

Surveyors use a transit or theodolite to help measure roadways, parks, dams, and building sites to help ensure proper construction and maintenance of these places. By knowing the area and slope of the parking lot, engineers can advise builders on where and how many drainage grates need to be included to ensure safe water runoff for users.

### Additional Resources

<table>
<thead>
<tr>
<th>Resource:</th>
<th>Purpose and Application:</th>
</tr>
</thead>
<tbody>
<tr>
<td>For students who need to review area and perimeter: Interactive website “Everything You Wanted to Know About Area and Perimeter”</td>
<td><a href="http://www.bgfl.org/bgfl/custom/resources_ftp/client_ftp/ks2/maths/perimeter_and_area/index.html">http://www.bgfl.org/bgfl/custom/resources_ftp/client_ftp/ks2/maths/perimeter_and_area/index.html</a></td>
</tr>
<tr>
<td>For students who need to review measurement equivalencies: Interactive website “Measurement Equivalents”</td>
<td><a href="http://www.harcourtschool.com/activity/con_math/g04c24.html">http://www.harcourtschool.com/activity/con_math/g04c24.html</a></td>
</tr>
<tr>
<td>National Program for Playground Safety:</td>
<td><a href="http://www.uni.edu/playground/">http://www.uni.edu/playground/</a></td>
</tr>
<tr>
<td>Maryland Playground Safety:</td>
<td><a href="http://fha.maryland.gov/ohpetup/eip_playground.cfm">http://fha.maryland.gov/ohpetup/eip_playground.cfm</a></td>
</tr>
</tbody>
</table>


Special needs resources:
http://www.cincinnatichildrens.org/svc/alpha/c/special-needs/resources/recreation.htm
http://www.snapplayground.org/

Credits
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Sandra Preiss – Editor

Teacher Reflections
• Were students focused and on task throughout the lesson? Insert answer here.
• If not, what improvements could be made the next time this lesson is used? Insert answer here.
• Were the students led too much in the lesson or did they need more guidance? Insert answer here.
• Did the students learn what they were supposed to learn? Insert answer here.
• How do you know? Insert answer here.
• How did students demonstrate that they were actively learning? Insert answer here.
• Did you find it necessary to make any adjustments during the lesson? Insert answer here.
• What were they? Insert answer here.
• Did the materials that the students were using affect classroom behavior or management? Insert answer here.
• What were some of the problems students encountered when using the …? Insert answer here.
• Are there better items that can be used next time? *Insert answer here.*
• Which ones worked particularly well? *Insert answer here.*

**Additional Comments**
Appendix A: Playground written assessment

Name ______________________

Show all work or thinking as you answer the following problems.

1. Show how to find the perimeter and area of this rectangle:

   perimeter: [4" + 8" + 4" + 8"

   area: [4" \times 8"

2. Show how to find the perimeter and area of this triangle:

   perimeter: [17' + 10' + 21']

   area: [\frac{1}{2} \times 8' \times 17']

3. Show how to find the circumference and area of this circle:

   perimeter: [2 \pi \times 7 cm]

   area: [\pi \times (7 cm)^2]

4. Explain what perimeter is, and give an example of when it would be used.
5. Explain what area is, and give an example of when it would be used.

**Fill in the blanks (show your work for full credit)**

6. 3 feet + 3 feet = ________ inches

7. 18 feet = _____ yards

8. 26 inches = _____ feet _____ inches

9. 11 yards = ______ feet

10. 5 cm = _____ mm

11. 5.5 m = ______ cm
12. 900 cm = _____ m

13. 3 m = _____ mm

14. 3 yards = ______ inches

15. Gerry is making a model of a slide that is 10 feet long. If he wants each inch on his model to equal 2 feet on the real slide, how long should his slide be? Show or explain how you decided.

16. Gertie’s scale model of a tree is 9 cm tall. If each cm on her model equals 3 m on the real tree, how tall is the real tree?
## Appendix B: Pre-Test / Post-Test Grading Rubric

<table>
<thead>
<tr>
<th>Category</th>
<th>3 points</th>
<th>2 points</th>
<th>1 point</th>
</tr>
</thead>
</table>
| 1. Show how to find the perimeter and area of this rectangle:  
**Perimeter:** 24 in.  
**Area:** 32 in² | All three are present: correct numbers, units, and work are provided. | 2 of the three present: correct numbers, units, and/or work are provided | 1 of the three present: correct numbers, unit, and/or work are provided. |
| 2. Show how to find the perimeter and area of this triangle:  
**Perimeter:** 48 ft.  
**Area:** 84 ft² | All three are present: correct numbers, units, and work are provided. | 2 of the three present: correct numbers, units, and/or work are provided | 1 of the three present: correct numbers, unit, and/or work are provided. |
| 3. Show how to find the circumference and area of this circle:  
**Circumference:** 43.96 cm  
**Area:** 153.86 cm² | All three are present: correct numbers, units, and work are provided. | 2 of the three present: correct numbers, units, and/or work are provided | 1 of the three present: correct numbers, unit, and/or work are provided. |
| 4. Explain what perimeter is, and give an example of when it would be used  
**Perimeter is described as the distance around a two-dimensional shape.** | Definition of perimeter is complete and accurate.  
Student provides an accurate example such as fence around a playground, sidewalk around a building, ribbon around a package, etc. | Definition of perimeter is incomplete but does convey a measurement in terms of a length.  
Student provides an accurate example such as: fence around a sidewalk around a building, ribbon around a package, etc. | Only a correct definition or example is provided. |
| 5. Explain what area is, and give an example of when it would be used  
**Area is described as the amount of space inside the boundary of a flat (2-dimensional) object such as a triangle or circle.** | Definition of area is complete and accurate.  
Student provides an accurate example such as: writing surface on a piece of paper, available space on a plate for food, how much carpet they have in their room, etc. | Definition of area describes amount of space within an object but does not differentiate between flat (2-D) and 3-D.  
Student provides an accurate example such as: writing surface on a piece of paper, available space on a plate for food, how much carpet they have in their room, etc. | Only a correct definition or example is provided. |
<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>6. 3 feet + 3 feet = inches</strong></td>
<td>Correct answer and written work is provided.</td>
<td>Only the correct answer or the written work is provided.</td>
</tr>
<tr>
<td><strong>7. 18 feet = 6 yards</strong></td>
<td>Correct answer and written work is provided.</td>
<td>Only the correct answer or the written work is provided.</td>
</tr>
<tr>
<td><strong>8. 26 inches = 2 feet 2 inches</strong></td>
<td>Correct answer and written work is provided.</td>
<td>Only the correct answer or the written work is provided.</td>
</tr>
<tr>
<td><strong>9. 11 yards = 33 feet</strong></td>
<td>Correct answer and written work is provided.</td>
<td>Only the correct answer or the written work is provided.</td>
</tr>
<tr>
<td><strong>10. 5 cm = 500 mm</strong></td>
<td>Correct answer and written work is provided.</td>
<td>Only the correct answer or the written work is provided.</td>
</tr>
<tr>
<td><strong>11. 5.5 m = 5500 cm</strong></td>
<td>Correct answer and written work is provided.</td>
<td>Only the correct answer or the written work is provided.</td>
</tr>
<tr>
<td><strong>12. 900 cm = 9 m</strong></td>
<td>Correct answer and written work is provided.</td>
<td>Only the correct answer or the written work is provided.</td>
</tr>
<tr>
<td><strong>13. 3 m = 3000 mm</strong></td>
<td>Correct answer and written work is provided.</td>
<td>Only the correct answer or the written work is provided.</td>
</tr>
<tr>
<td><strong>14. 3 yards = 108 inches</strong></td>
<td>Correct answer and written work is provided.</td>
<td>Only the correct answer or the written work is provided.</td>
</tr>
<tr>
<td><strong>15. Gerry is making a model of a slide… how long should his slide be? 5 inches</strong></td>
<td>Student provides correct answer; and shows their work; and accurately explains decision.</td>
<td>Student provides 2 of the 3: correct answer; shows their work; and/or accurately explains decision.</td>
</tr>
<tr>
<td><strong>16. Gertie’s scale model of a tree is 9 cm tall… how tall is the real tree? 27 meters</strong></td>
<td>Student provides correct answer; and shows their work; and accurately explains decision.</td>
<td>Student provides 2 of the 3: correct answer; shows their work; and/or accurately explains decision.</td>
</tr>
<tr>
<td><strong>Total possible points</strong></td>
<td></td>
<td>39 points</td>
</tr>
</tbody>
</table>
## Appendix C: Student Participation Rubric

<table>
<thead>
<tr>
<th>CATEGORY</th>
<th>3</th>
<th>2</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Contributions</strong></td>
<td>Provides useful ideas when participating in the group and in classroom discussion. A strong group member who tries hard!</td>
<td>Sometimes provides useful ideas when participating in the group and in classroom discussion. A satisfactory group member who does what is required.</td>
<td>Rarely provides useful ideas when participating in the group and in classroom discussion. May refuse to participate.</td>
</tr>
<tr>
<td><strong>Quality of Work</strong></td>
<td>Provides high quality work.</td>
<td>Provides work that occasionally needs to be checked/redone by other group members to ensure quality.</td>
<td>Provides work that usually needs to be checked/redone by others to ensure quality.</td>
</tr>
<tr>
<td><strong>Time-management</strong></td>
<td>Routinely uses time efficiently throughout the project to ensure things get done on time. Group does not have to adjust deadlines or work responsibilities because of this person's procrastination.</td>
<td>Tends to procrastinate, but always gets things done by the deadlines. Group does not have to adjust deadlines or work responsibilities because of this person's procrastination.</td>
<td>Rarely gets things done by the deadlines AND group has to adjust deadlines or work responsibilities because of this person's inadequate time management.</td>
</tr>
<tr>
<td><strong>Problem-solving</strong></td>
<td>Actively looks for and suggests solutions to problems.</td>
<td>Refines solutions suggested by others.</td>
<td>Does not try to solve problems or help others solve problems.</td>
</tr>
<tr>
<td><strong>Working with Others</strong></td>
<td>Almost always listens to, shares with, and supports the efforts of others. Tries to keep people working well together.</td>
<td>Usually listens to, shares with, and supports the efforts of others.</td>
<td>Rarely listens to, shares with, and supports the efforts of others. Often is not a good team player.</td>
</tr>
</tbody>
</table>

| **Total Participation Grade** | ____/15 points |
Appendix D: Playground Project Rubric

Design parameters:
- Each playground must include 4 structures (a slide, climbing structure, swing set, and at least one other piece of equipment).
- The playground cannot have an area of more than 5,000 ft².
- Include a fence around the perimeter of the area of the playground.
- You can get extra points by applying good citizen thinking and make sure that your playground is handicapped accessible and useable.

<table>
<thead>
<tr>
<th>Category</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design</td>
<td>All of the following requirements are met:</td>
<td>3 of the 4 requirements are met.</td>
<td>2 of the 4 requirements are met.</td>
<td>1 of the 4 requirements are met.</td>
</tr>
<tr>
<td></td>
<td>1. The design is on grid paper.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. Components are drawn to scale including accurate fall zones.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. An accurate key is present.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>4. Design is neat and labeled.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Formula sheet</td>
<td>All of the following are present on the formula sheet:</td>
<td>3 of the 4 are present on the formula sheet.</td>
<td>2 of the 4 are present on the formula sheet.</td>
<td>1 of the 4 are present on the formula sheet.</td>
</tr>
<tr>
<td></td>
<td>1. All necessary mathematical formulas are present.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. Sheet is organized.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. Each equation is present.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>4. Each answer identifies or indicates what formula was used for each calculation.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Playground design</strong></td>
<td>Design includes all 4 structures: swing, slide, climbing structure, and at least 1 other piece of play equipment.</td>
<td>Design includes 3 of the 4 structures.</td>
<td>Design includes 2 of the 4 structures.</td>
<td>Design includes 1 of the 4 structures.</td>
</tr>
<tr>
<td>----------------------</td>
<td>-------------------------------------------------------------------------------------------------</td>
<td>-----------------------------------</td>
<td>-----------------------------------</td>
<td>-----------------------------------</td>
</tr>
<tr>
<td><strong>Fence perimeter and mulch volume</strong></td>
<td>The correct amount of fence and mulch has been calculated. Units are correct for both calculations.</td>
<td>One of the following is incorrect: Amount of fence, amount of mulch, units for fence or units for mulch.</td>
<td>Two of the following is incorrect: Amount of fence, amount of mulch, units for fence or units for mulch.</td>
<td>Three of the following is incorrect: Amount of fence, amount of mulch, units for fence or units for mulch.</td>
</tr>
<tr>
<td><strong>Price guide</strong></td>
<td>Data is organized and contains prices for all equipment including fencing and mulch. (6 prices should be provided)</td>
<td>Data is organized. However, one price is incorrect or missing.</td>
<td>Data is organized. However, two prices are incorrect or missing.</td>
<td>Data is organized or 3 or more prices are incorrect or missing.</td>
</tr>
<tr>
<td><strong>3-D models</strong></td>
<td>All four models were creatively and accurately constructed with the scale identified.</td>
<td>At least three models were creatively and accurately constructed with the scale identified.</td>
<td>At least two models were accurately constructed with the scale identified.</td>
<td>Models may be creative but no scale was identified so accuracy cannot be determined.</td>
</tr>
<tr>
<td><strong>Presentation</strong></td>
<td>All group members participated. Design, 3-D pieces, and price guide were presented. Presentation was clear, organized and creative.</td>
<td>All group members participated. Design, 3-D pieces, and price guide were presented. Presentation was easy to understand.</td>
<td>Some group members may not have participated. One major component might be missing. Presentation may have been confusing or unclear.</td>
<td>Some group members may not have participated. Major components were missing. Presentation was confusing or unclear.</td>
</tr>
<tr>
<td><strong>Playground area</strong></td>
<td>Playground does not exceed an area of 5,000ft²</td>
<td>(4 points)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Extra Credit</td>
<td>Good Citizen thinking! Playground design is handicapped accessible and useable. (4 points)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>--------------</td>
<td>------------------------------------------------------------------------------------------------</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Extra Credit</td>
<td>An additional element was added to the playground, prices and models are included for this/these element(s) (4 points)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Score</td>
<td>____/32</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Appendix E: Playground Research Organizer

<table>
<thead>
<tr>
<th>What can be done to make playgrounds safer?</th>
<th>What is a fall or safety zone? How do you calculate it?</th>
<th>What is the maximum height for your piece of equipment? The minimum?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Source:</td>
<td>Source:</td>
<td>Source:</td>
</tr>
<tr>
<td>What geometric shape(s) make your piece of equipment?</td>
<td>How do you calculate how far away each piece of equipment should be?</td>
<td>Other questions I have:</td>
</tr>
<tr>
<td>Source:</td>
<td>Source:</td>
<td>Source:</td>
</tr>
</tbody>
</table>
Above: Three swings with side bench
Below: Monkey bar
Above: Shimmy bars beneath the monkey bars
Below: Ring trek beneath the monkey bars
Rope ladder & Climbing wall

Step ladder, chain ladder, rope ladder