WALCH EDUCATION

Expeditions

IN YOUR CLASSROOM

for Common Core State Standards

STATE COMMON CORE STANDARDS

Geometry

Contents

Project Skills Chart

Projects challenge students to flex more than one mental muscle at a time and integrate skills they often see dissected and covered in discrete math book chapters. Each project in this book has a core skill focus, but also gives students an opportunity to practice other skills. Use this chart as a reference to help you find the best project for your needs.

C = Core skill

X = Other skills covered (sometimes optional)

Project	Page	Measurement	Ratio and proportion	Scale drawing	Classifying polygons	Triangle and angle measurements	Polygon measurements	Circle geometry	Three-dimensional shapes and visualization	Transformations	Coordinate systems	Calculating slope	Geometric modeling	Graph theory	Basic trigonometry
Project Putt-Putt	1	X	X	C		C	X		X	X		X			
Ripping Rooms	18	X	X	C	C	X	C	X							
Fashionistas	40	X	C	X			X		C						
At the Scene of the Crime	64	X	X	C			C				C				
Protectors of the Realm	95	X				X	X				C		C		
Superhero Challenge	113	X		X		X					X		C	C	
Thinking Outside the Box	130	X	X	X		X		X	C	X					
Director's View	151	X		X		X		C							C
This Is Air Traffic Control	168	X		X		X			X		C				C
The Great Geometry Race	195	X	X		X	X	X	X	X	X	X	X			

Geometry Project Assessment Rubric

	Percent of grade	4 (Excellent)	3 (Good)	2 (Fair)	1 (Poor)
Knowledge and skills specific to project		Defines all key vocabulary, with examples. Recalls all formulas and methods correctly; can explain and apply to other problems. If required, work shows evidence of research on topic or theme.	Defines majority of terms, with examples. Majority of formulas and methods applied correctly. Can apply to other problems with some incorrect answers. Shows evidence of research.	Definitions and explanations are confusing or incorrect. Some formulas are used correctly. Shows little evidence of research.	No knowledge evident. There are few correct methods and few correct answers. There is no evidence of research.
Measurement/ calculations		Uses correct formulas. Includes all calculations and diagrams used for solution. Answers are correct.	Majority of formulas are correct. Most work is shown. There are some incorrect answers.	Some formulas are used correctly. Some work is shown. There are a number of incorrect answers.	There are few correct formulas, little work shown, and a small number of correct answers.
Drawing and modeling		Final work meets criteria and exceeds expectations. All elements are included and correctly labeled. Work shows mastery of technique/technical skill. If required, scale and proportion are represented accurately.	Final work meets criteria. Majority of elements are included and labeled. Work shows good command of technique/technical skill. If required, scale and proportion are represented accurately.	Final work is missing important elements. Technique is weak. Scale and proportion are not represented accurately.	Did not do work/contribute. Did not attempt to learn technique.
Level of challenge		Investigated difficult or complex situations.	Investigated moderately difficult situations.	Investigated straightforward situations.	Investigated simplest or easiest situations.
Final product		Meets all criteria. Organization and information exceed expectations. Work reflects excellent understanding of project content.	Meets all criteria. Organization and information are presented clearly. Work reflects good understanding of project content.	Meets most criteria. Some elements or components are missing.	Did not contribute. Did not submit or is missing major components.

Geometry Project Assessment Rubric, *continued*

	Percent of grade	4 (Excellent)	3 (Good)	2 (Fair)	1 (Poor)
Presentation		Completed within specific time. Evidence of preparation is obvious. Emphasized most important information. All team members were involved.	Almost completed within time. Some preparation is evident. Covers majority of main points. Not all team members were involved.	Almost completed within time. Little preparation is evident. Misses a number of important points. Not all team members were involved.	Did not participate, did not prepare, was way under or over time, or information was confusing and disjointed.
Teamwork		Workload was divided and shared equally by all members.	Most members, including student, contributed fair share.	Workloads varied considerably. Student did not contribue fair share.	Few members contributed. Student made little to no contribution.
Class participation		Contributed substantially.	Contributed fair share.	Contributed some.	Contributed very little.

Project Putt-Putt

Overview

Students design a miniature golf course. They create blueprints and a model for a new championship course.

Time

Total time: 6 to 8 hours

- Before You Go—Reflection Inspection: 30 to 55 minutes
- Before You Go—Uphill and Downhill: 15 minutes
- Activity 1—Putt-Putt Blueprints: two to four 55-minute class periods
- Concept sketch development: one to two 55-minute class periods
- Scale drawings: one to two 55-minute class periods and one to two hours of homework
- Activity 2—Mini Model: one to two 55-minute class periods and one to two hours of homework

Skill Focus

- angles and reflection
- slope
- two- and three-dimensional modeling

Prior Knowledge

- measurement
- drawing to scale
- basic understanding of angles and their properties

Team Formation

Students can work individually or in teams of two or three students.

Lingo to Learn—Terms to Know

- **angle of incidence:** the angle that a line makes with a line perpendicular to the surface at the point of incidence
- **angle of reflection:** angle measurement between a reflected ray and a line perpendicular to the reflecting surface/line at the point of incidence
- **area:** the number of square units needed to cover a surface
- **congruence:** when figures or angles have the same size and shape
- **isometry:** symmetry; a transformation that is a reflection or a composite of reflections (reflections, rotations, translations/slides, and glide reflections are isometries)

Project Putt-Putt

- **line of reflection:** a line used to create a reflection of a shape (reflecting line or mirror)
- **perimeter:** the sum of the lengths of the sides of a polygon
- **ratio:** a pair of numbers that compares different types of units
- **reflection:** a transformation resulting from a flip
- **scale drawing:** a drawing that is a reduction or an enlargement of the original
- **slope:** the steepness of a line; the measure of change in a surface value over distance

Suggested Steps

Preparation

- Review the list of materials and collect anything you will provide (a golf ball and marble for each team, art supplies, and so forth).
- Review the Miniature Golf Course Hole Specifications in Activity 1. Adapt specifications to fit your skill focus. For example, you may wish to make sloped elements optional.

Day 1

1. Provide an overview of the project and review materials.
2. Facilitate Before You Go: Reflection Inspection, which addresses angles of reflection. Let students practice and discuss observations. Show how to calculate angles of incidence and reflection using the tangent function.
3. Introduce Before You Go: Uphill and Downhill, an activity on how to determine the slope and angle of slope of an incline.

Homework

If students have Internet access at home, have them use the Helpful Web Resources to learn about golf course design and look for examples of miniature golf courses. Encourage them to visit sites that highlight interesting or famous miniature golf courses.

Day 2

1. Explain Activity 1: Putt-Putt Blueprints.
2. Review course holes and drawing specifications. Provide any specific criteria you have (for example, if you do not want students to include slope).
3. If this is not an individual project, ask students to select a partner or assign groups.

4. Provide due dates for assignments (freehand sketches, scale drawings) and/or specify whether class time will be used.
5. Give students a refresher on ratio and scale if needed.
6. Allow students to begin brainstorming and planning course hole ideas.

Homework

Have students continue to brainstorm ideas for their course holes and create a freehand sketch.

Days 3 through 5

1. Give students time to work on drawings. Alternatively, if done as homework, ask students to show signs of progress each day.
2. Invite students to describe their ideas, show a first draft or revised sketch, and so forth.
3. Check with students to make sure they are on target. Clarify any misconceptions.

Design Due Date

1. Have students hang design drawings around the classroom.
2. Allow 5 to 10 minutes for viewing.
3. Solicit observations and feedback. Discuss any design or construction challenges evident in drawings.
4. Explain Activity 2: Mini Model. Review 3-D model criteria. Add other criteria appropriate to your situation and supplies.
5. Assign a due date for models.

Model Due Date

1. Position course holes on desks around the classroom. Number each hole.
2. Give students wooden craft sticks and marbles.
3. Let students play a few rounds. You might also have them track scores on improvised score cards—notebook paper with three columns for hole number, hole par, and score.

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4. Evaluate the course. Discussion questions might include:
   - Did anyone get a hole in one?
   - Which course holes were most challenging and why? Which course holes were least challenging?
   - Does understanding reflection help your game?

Final Day

1. Have students complete the Skill Check problems.
2. Check and review answers.
3. Have students complete the Self-Assessment and Reflection worksheet and submit it (optional).

Project Management Tips and Notes

- Review proposed designs. Student course holes tend to get complex! Some students may need redirection to simplify the design. Others may need a gentle reminder that the geometry of the course hole and how it plays are more important than appearance.
- As written, the project specifies that course holes be as big as a student's desk and no bigger than two or three desks. You may want to limit designs to one desktop. This is great for practical reasons (supplies, space); however, students may find the space tight for a course hole that should include two bounces and a slope. You can also give a range of dimensions (for instance, larger than 2 feet by 2 feet but smaller than 4 feet by 4 feet). The space doesn't need to be square.

Suggested Assessment

Use the Geometry Project Assessment Rubric or the following point system:

Team and class participation	15 points
Two scaled hole drawings	40 points
3-D course hole model	40 points
Project self-assessment	5 points

Project Putt-Putt

Extension Activities

- Technologically inclined students may use The Geometer's Sketchpad (www.dynamicgeometry.com) or other tools to calculate and model angles before creating sketches.
- Consider having students use a computer-aided design (CAD) program to draft a blueprint or three-dimensional model of their course hole.
- Explore other angles involved in golf: a golf swing, golf clubs, the position of course holes in relation to one another, and so forth.
- Ask students to identify and price the materials they need to build their course hole.
- As a class, design and build a real miniature golf course. Hold a tournament involving local leaders. Use the event as a fund-raiser. (See Junkyard Golf & Potluck: http://junkyardsports.com/events/golfest.pdf)

Common Core State Standards Connection

High School

Geometry: Modeling with Geometry

G-MG.1. Use geometric shapes, their measures, and their properties to describe objects (e.g., modeling a tree trunk or a human torso as a cylinder).★

G-MG.3. Apply geometric methods to solve design problems (e.g., designing an object or structure to satisfy physical constraints or minimize cost; working with typographic grid systems based on ratios).★

Number and Quantity: Quantities★

N-Q.1. Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.

N-Q.3. Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.

Grade 8

Geometry

8.G.2. Understand that a two-dimensional figure is congruent to another if the second can be obtained from the first by a sequence of rotations, reflections, and translations; given two congruent figures, describe a sequence that exhibits the congruence between them.

Grade 7

Geometry

7.G.2. Draw (freehand, with ruler and protractor, and with technology) geometric shapes with given conditions. Focus on constructing triangles from three measures of

Project Putt-Putt

angles or sides, noticing when the conditions determine a unique triangle, more than one triangle, or no triangle.

7.G.6. Solve real-world and mathematical problems involving area, volume, and surface area of two- and three-dimensional objects composed of triangles, quadrilaterals, polygons, cubes, and right prisms.

Grade 6

Ratios and Proportional Relationships

6.RP.3d. Use ratio reasoning to convert measurement units; manipulate and transform units appropriately when multiplying or dividing quantities.

Answer Key

Before You Go: Uphill and Downhill

1. Slope

   $m = \Delta y/\Delta x$

   $m = 9/18$

   $m = 1/2$ or 50%

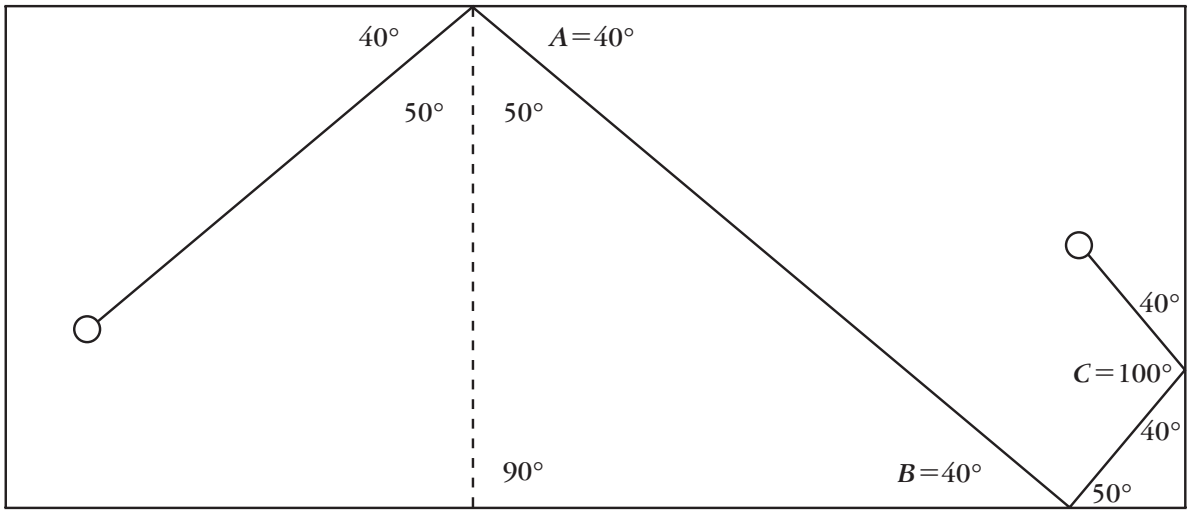
2. Slope

   $m = \Delta y/\Delta x$

   $m = 8/10$

   $m = 4/5$ or 80%

Check Yourself! Skill Check

1. Answers will vary.
2. 

Project Putt-Putt

Expedition Overview

Challenge

The International Pro Miniature Golf Tour is coming to your area. You are a tour champion turned course designer and have been asked to construct a unique and challenging course for the championship event. Tour planners want to see blueprints and a model immediately!

Objectives

- To explore transformational geometry and learn how to calculate angles of reflection
- To calculate slope and angle of slope
- To use measurement and geometry skills to create accurate scale drawings

Project Activities

Before You Go

- Reflection Inspection
- Uphill and Downhill

Off You Go

- Activity 1: Putt-Putt Blueprints
- Activity 2: Mini Model

Other Materials Needed

- golf balls
- graph paper
- paper
- colored pencils or crayons
- ruler
- protractor
- cardboard or poster board
- other recyclable construction materials (for example, paper towel rolls, containers, box covers, paper cups)
- other art supplies (for example, construction paper, felt, water-soluble paint, clay)
- scissors
- glue
- masking tape
- marbles
- wooden craft sticks

Project Putt-Putt

Expedition Overview

Lingo to Learn—Terms to Know

- angle of incidence
- angle of reflection
- area
- congruence
- isometry
- line of reflection
- perimeter
- ratio
- reflection
- scale drawing
- slope

Helpful Web Resources

- History of Miniature Golf
  www.terrastories.com/bearings/miniature-golf
- IgoUgo—A Field Guide to Mini-Golf
  www.igougo.com/story-s1214255-Myrtle_Beach-A_Field_Guide_to_Mini-Golf.html
- Professional Miniature Golf Association—Mini Golf Madness on The Travel Channel
  www.thepmga.com/Players/News/Mini_Golf_Madness/mini_golf_madness.php
- Professional Miniature Golf Association—Miniature Golf, Mathematically Speaking
  www.thepmga.com/Players/News/Geometry/geometry.php
- RekenWeb Games—KidsKount
  www.fi.uu.nl/rekenweb/en/welcome.xml
  (Click on "Mini Golf" link.)
- U.S. ProMiniGolf Association—U.S. Miniature Golf and Mini Golf Courses
  http://prominigolf.com/uscourses.html

Project Putt-Putt

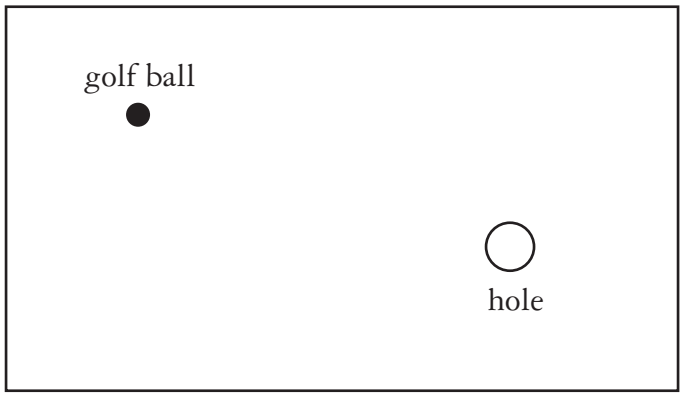
Before You Go

Reflection Inspection

Goal:	To learn about reflection
Materials:	one golf ball per group, graph paper, masking tape, pencils

Directions

1. Form your group. Gather materials and put the golf ball aside.
2. Using graph paper, draw a line 4 to 5 inches long that represents a wall of your classroom. Decide how far from the line (wall) you want to position your hole. Mark this point on the graph paper. Label your hole point *H*. At the bottom of your graph paper, choose a point that represents your golf ball. Make the distance between this point and the line different from that of point *H* and the line. Label your ball point *B*.
3. Pause for group discussion. Make predictions about the path the ball will take for a hole in one. Take turns sharing how you would visualize the path and mentally gear up for the shot.
4. Draw the path on the grid. Label it "Shot 1."
5. Next, move the hole to a new location. Draw a second path. Label it "Shot 2."
6. Test your predictions. Select a section of wall. Use small pieces of masking tape to mark the ball starting point and your "hole."
7. Experiment with more shots by changing positions of the ball and the hole. If you have access to a space with two walls or solid vertical surfaces, try a few double-bounce or even triple-bounce shots. Don't forget to make predictions first.
8. Check your reflection prediction skills one more time. Show the path for a one-bounce or two-bounce hole in one below.



Project Putt-Putt

Before You Go

9. What other factors might affect the path of a golf ball on a miniature golf course? Write your ideas below.

Project Putt-Putt

Before You Go

Uphill and Downhill

Goal: To review how to determine the slope and angle of slope of an incline

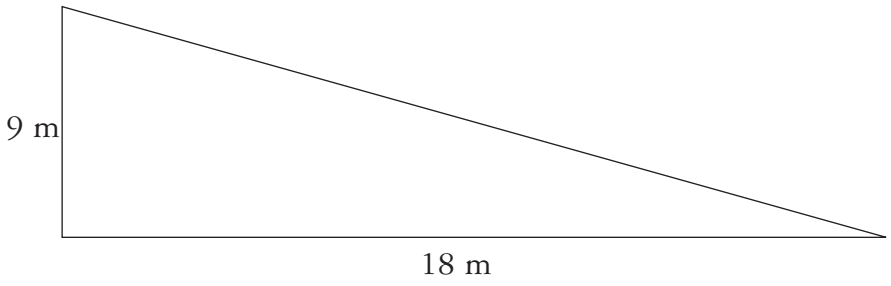
Miniature golf courses often include interesting topography, including sloped or graded surfaces such as ramps, steps, or embankments along the sides. How steep such an incline is can be described by calculating the slope.

Slope: $m = \frac{\Delta y}{\Delta x}$ or "rise over run" given as a ratio or percentage

Directions

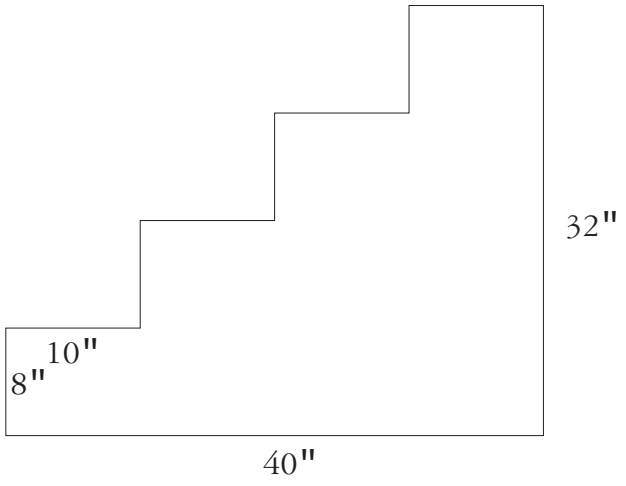
Determine the slope for each diagram below.

1.



Slope: _____

2.



Slope: _____

Project Putt-Putt

Before You Go

Activity 1: Putt-Putt Blueprints

Goal:	To create a scale drawing for a miniature golf hole of your own design
Materials:	computer with Internet access, colored pencils or crayons, paper, graph paper, marbles

Directions

1. Use your Helpful Web Resources and the Internet to learn about miniature golf course design. Be sure to take a look at some of the world's most interesting and more well-known miniature golf courses.
2. Review the specifications for your miniature golf hole and develop three different hole ideas. Be creative! For example, choose a theme, a unique location, or interesting topography for your course hole.

Miniature Golf Course Hole Specifications

- ❑ The "golf ball" will be a marble.
- ❑ Players should not be able to sink a ball in one straight shot. Your goal is to provide a challenge!
- ❑ The ball must bounce off course sides and/or obstacles at least twice for a hole in one.
- ❑ The hole must include obstacles, twists, or turns.
- ❑ The design should use at least three quadrants of graph paper.
- ❑ Include at least one incline or decline. Vertical drops may also be included.
- ❑ *Challenge:* There should be at least two unique shots a player could use to get a hole in one.

3. For each of your three ideas, create one freehand aerial view sketch. Show what your course hole would look like. Label important elements of the course (tee, hole, obstacles). Add other fun details—the name of the hole, a snack bar, a clubhouse, and so forth.

(continued)

Project Putt-Putt

Off You Go

4. Review your ideas. Get feedback. Test each concept! For example, use a small ball or marble and other temporary objects to test possible shots, angles, reflection, level of difficulty, and so forth.
5. Choose one idea. Create two accurate scale drawings for this idea: an aerial view and a cross-sectional (side) view. Follow the Scale Drawing Criteria below.

Miniature Golf Course Scale Drawing Criteria

- ❑ Draw the sketch accurately to scale.
- ❑ Provide a legend indicating scale.
- ❑ Use lines exactly where the ball would travel. *Tip:* Make a photocopy of your aerial view drawing and use the photocopy as a draft until you are sure you have the paths.
- ❑ Mark the points the ball must bounce off of for each hole in one.
- ❑ Provide distance and angle measurements. Include the following measurements:
  - ❑ perimeter of the course
  - ❑ height of sides
  - ❑ length and width of the course or course sections
  - ❑ location of the tee, hole, and other obstacles relative to sides and other course elements
  - ❑ total surface area of the hole
  - ❑ obstacle dimensions (height, width, clearance, etc. as appropriate)
  - ❑ diameter, circumference, and length of any tunnels included
  - ❑ slope and angle measurements for course inclines
  - ❑ height of any vertical drops
- ❑ Work is to be neat and colorful. Course elements should be well-labeled (tee, hole, obstacles).

General rule: If an item on your course can be measured, provide a measurement. For example, if you include a dinosaur obstacle, provide the height, the width at the base, the distance between the dinosaur's feet, and the clearance under the obstacle.