Module 1.0: Golf Measurements

Part 1: Pythagorean Theorem

$A^2 + B^2 = C^2$

1 mm = 10 yard *Answers may vary, if copied at a different scale. Recommend measuring a student's copy prior to grading.*

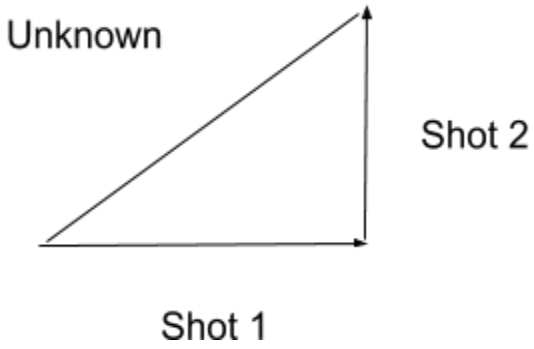
	Measured	*Calculated*
1		*473 yards*
2	*340 yards*	
3	*260 yards*	
4		*420 yards*
5	*330 yards*	
6		*474 yards*
7	*640 yards*	
8	*430 yards*	
9		*263 yards*

Answers will vary based on student shot distance. Examples provided.

Shot 1 (A) = ____23 yards_____

Shot 2 (B) = ____43 yards_____

Unknown (C) = ____48.7 yards_____



Part 2: Area of a Circle

$A=\pi r^2$

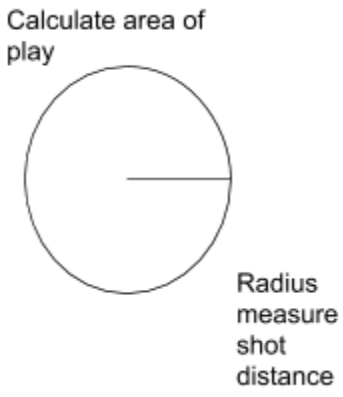
1 mm = 1 yard *Answers may vary if copied at a different scale. Recommend measuring a students copy prior to grading.*

	Diameter	Radius	Area
1-Sand Trap	4 yards	2 yards	12.5 yards^2
2-Water hazard	3 yards	1.5 yards	7 yards ^{2}
3-Water hazard	2 yards 3 yards	1 yard 1.5 yards	3 yards^2 7 yards ^{2}
4-Sand Trap	7 yards	3.5 yards	38 yards ^{2}
5-Sand Trap	6 yards	3 yards	28 yards^2
6-Sand Trap	6 yards	3 yards	28 yards^2
7-Sand Trap	8 yards	4 yards	50 yards^2
8-Water hazard	4 yards 5 yards	2 yards 2.5 yards	12.5 yards^2 19.6 yards^2
9-Water hazard	5 yards	2.5 yards	19.6 yards^2

Answers will vary based on student shot distance. Examples provided.

Shot Distance (r) = ___16 yards_____

Area of play (A) = __804 yds^2_____



Module 2.0: Force of a Golf Swing

How far can you hit a golf ball?

Estimate: _____ yards
Answers will vary.

	Trial 1	Trial 2	Trial 3	Average Drive
Drive				

Write a hypothesis on how you can increase your average drive distance.
Answers will vary.

Scaffold Experiment Guide: Answers will vary for student designed experiments and scaffolded experiments.

Module 3.0: Scoring in Golf

Answers will vary based on student data. Example data provided.

Reminder to the teacher/instructor: Set the par for your 'course' for the student's ability level.

Hole	1	2	3	4	5	6	7	8	9	OUT
Par	3	4	2	3	5	4	6	3	5	35
Person 1	2	3	2	5	4	5	3	4	3	31
Person 2	3	2	2	3	4	4	4	3	4	29
Person 3	3	4	3	3	5	4	6	3	4	34
Person 4	3	4	2	3	4	3	5	3	5	32

Write a mathematical expression for how you could calculate your score for each hole.

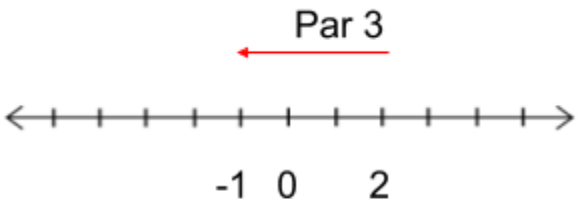
Answers will vary. Example: Number of shots - Par

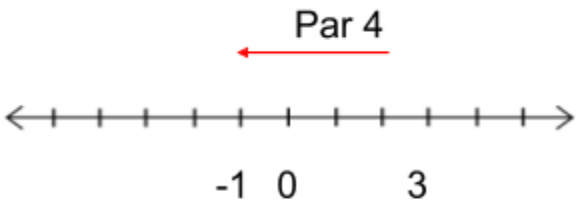
Write a mathematical expression for how you could calculate your score for the game.

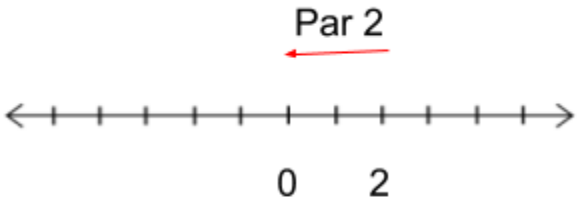
Answers will vary. Example: Sum (Hole 1 to 9) - 35

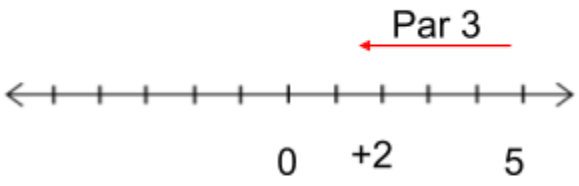
Use your expression and the number lines below to calculate your score. Start with the hits and then subtract par.

Answers will vary based on number line strategy. Using example data below for the first 4 holes, player 1.

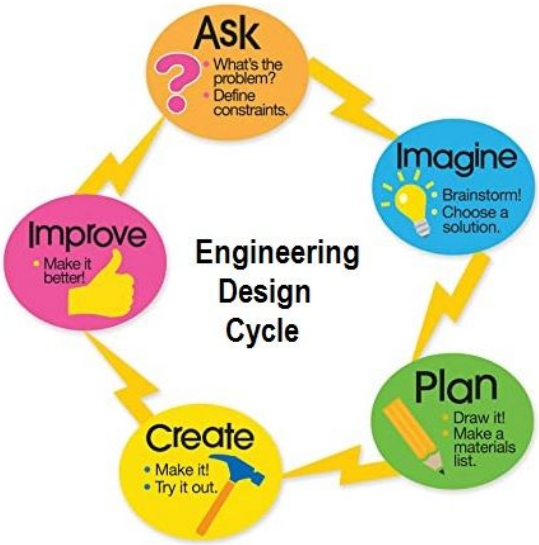

Par 3
-1
0
2


Par 4
-1
0
3


Par 2
0
2


Par 3
0
+2
5

Module 4.0: Engineering a Pushcart



Brainstorming: Answers will vary based on student responses.

solutions if you have a million dollars	**solutions that involve motorization**
solutions that start with letter ___	**solutions that you could build**

Fill in the criteria and constraints for your design challenge. Consider impacts on people (accessibility) and the natural environment. Answers will vary.

Criteria	Constraints
Example criteria: easy for kids to use; can be pushed or pulled; easy for people with disabilities to use.	Example constraints: must be made of recycled materials; may only have a maximum of two wheels.

Module 5.0: What is a Golf Ball?

THE GOLF BALL EVOLVED: Questions

1. What were some of the constraints for the first golf ball? Why did golfers feel the need to make changes? Answers will vary.
   Example: various sizes, weight and materials. The ball took a lot of time and money to construct and would often be damaged after multiple uses.

2. How has the anatomy of golf balls changed over time? What drove this change?
   Answers will vary.
   Example: The materials and uniform weight and size were the biggest changes. This was due to access and cost of materials, construction time and reproductivity.

3. What criteria and constraints did golf industry engineers need to consider in the early 1900's? Answers will vary.
   Example: The criteria was a ball that increased the trajectory and length. Constraints were creating golf balls that were the same shape, size and weight.

4. Why are there multiple golf balls in today's golf game? Answers will vary.
   Example: Each player has different needs and skills, so they want a different performance type from the ball.

5. Why do you think it was necessary for the international golf governing bodies to regulate the mass and size of the golf ball? Support your claim with evidence and reasoning.
   Answers will vary.
   Example: The need to regulate mass and size of the golf ball was to eliminate any advantages or disadvantages that varying mass and size would create. As we saw in 'The Force of a Swing' module, small changes can make a difference in distance and number of strokes in a game. Mass also impacts how far, height, and fast the ball may travel.

6. What is the author's purpose of this article? Provide text evidence to support your claim.
   Answers will vary.
   Example: The author's purpose is to inform the audience about how technology of golf balls has changed over time. In the first paragraph, the author states that golf has evolved more than other sports. The author uses various dates throughout the article from 1618 to today, describing multiple major changes to the golf ball. In the fifth paragraph, the author discusses a significant material change from the traditional leather stuffed ball.

Using the article and classroom discussion fill in the following criteria and constraints table: Answers will vary; some examples are included below.

Criteria	Constraints
Uniform Shape Uniform Mass Uniform Size Increases distance of the shot	Cost Available material Reproducibility

Answers will vary.

	Qualitative Observations	Quantitative Observations
Golf Ball 1 (2 layer)		
Golf Ball 2 (3 layer)		
Golf Ball 3 (4 layer)		

Sample Data: Distance to target is 7 yards. The sample data demonstrates that the tennis ball, ping pong ball, and golf ball #3 over shot the target.

Trial # _____

	Number of putts to hit the target	Distance of Putt 1	Distance of Putt 2	Distance of Putt 3	Distance of Putt 4	Distance of Putt 5
Tennis ball	6	3 yards	6 yards	4 yards	2 yards	1 yard
Ping Pong Ball	8	4 yards	4 yards	3 yards	2 yards	3 yards
Golf Ball1 (2 layer)	3	5 yards	1 yards	1 yards		
Golf Ball 2 (3 layer)	2	6 yards	1 yard			
Golf Ball 3 (4 layer)	3	6 yards	2 yards	1 yard		

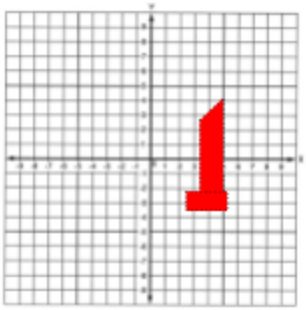
Complete the following statement and support your claim with evidence from the article and experiment, and support it with reasoning regarding the criteria and constraints.
Answers will vary based on student ability and performance goals. Example response:
"Ball number _2_ is the best technologically engineered ball for the game of golf."
In the experiment, the 3 layer ball reached the target in the fewest hits. It was also easier to control and I didn't overshoot the target. The reason for the increased control is the thin layers of plastic covering. The ball stays in control even when I hit it hard due to the high density/solid core (increasing spin speed).

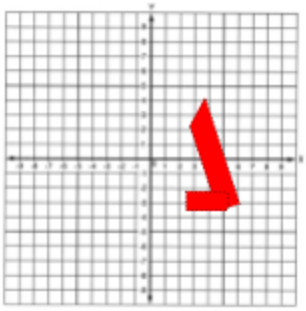
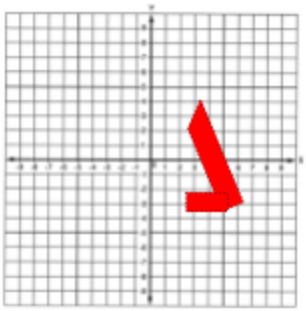
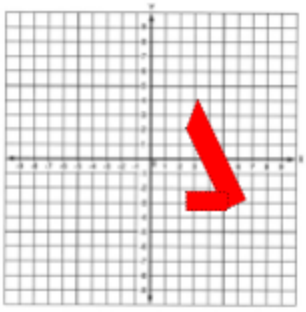
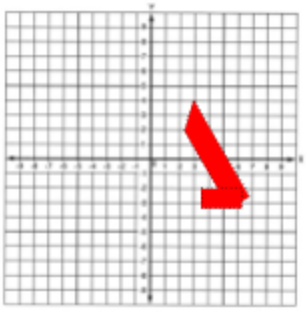
6.0: Angles

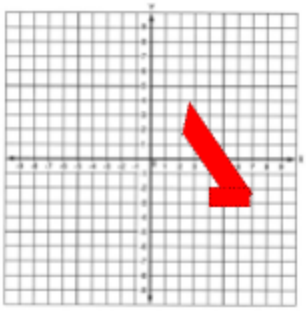
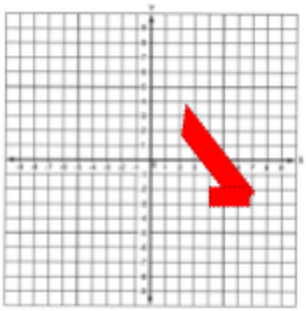
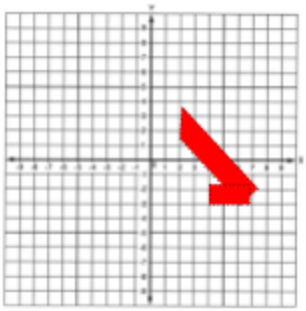
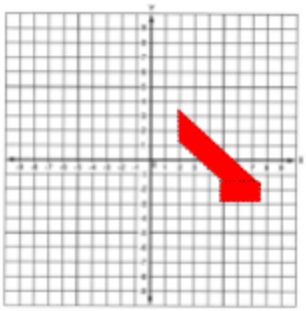
Data Table 1 Answers will vary.

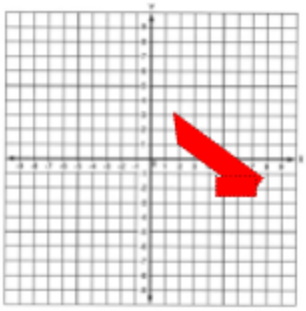
Club	Picture	Qualitative observations	Measured Club Slope
Putter			
3 Iron			
4 Iron			
5 Iron			
6 Iron			
7 Iron			
8 Iron			
9 Iron			
PW			
SW			

Data Table 2 Answers will vary for average distance traveled, if extending. Sample data is from the average distance chart in the module.

Club	Picture	Geometric Shape resprestiation	Angle of club face (complementary angle)	Average distance traveled
Putter			90	N/A

3 Iron			69	125 yards
4 Iron			66	120 yards
5 Iron			63	110 yards
6 Iron			59	100 yards

7 Iron			55	90 yards
8 Iron			51	80 yards
9 Iron			47	70 yards
PW			43	60 yards

SW			34	50 yards

Using your data and diagram, make a claim and support it with evidence and reasoning that answers the following question: What is the relationship between the angle of a club face and the distance the ball will travel?

Answers will vary.

Example expresses ideas from multiple lessons. Example: As the angle of the club face decreases, the average distance decreases. The club face angle is actually the complimentary angle of the club slope. For example, the club slope of a sand wedge is 56° and the club face angle is 34°. Because of the angle, when a player hits the ball it creates upward lift instead of a forward push. When the ball has more upward lift, it travels less before gravity brings it back to earth. Whereas a 3 Iron has a higher angle of 69° and more forward push is created, ensuring that it will have enough kinetic energy to travel further. Therefore, the lower the angle of the club face, the less distance it will go.

Module 7.0: Kinetic Energy in Golf

Which ball has the most energy when hit with the ShortGolf club? (circle one)
Answers will vary based on prior knowledge and misconceptions.

Ping Pong ball ShortGolf ballz!

Trial 1 Answers will vary based on students data. Sample data below.

	Distance (meters)	Time (Seconds)	Velocity (m/s)
Ping Pong Ball	30 m	2 s	15 m/s
ShortGolf ballz!	45 m	1.5 s	30 m/s

Trial 2

	Distance (meters)	Time (Seconds)	Velocity (m/s)
Ping Pong Ball	30 m	2 s	15 m/s
ShortGolf ballz!	45 m	1.5 s	30 m/s

Trial 3

	Distance (meters)	Time (Seconds)	Velocity (m/s)
Ping Pong Ball	30 m	2 s	15 m/s
ShortGolf ballz!	45 m	1.5 s	30 m/s

	Average Velocity (m/s)	Mass	Kinetic Energy (joules)
Ping Pong Ball	15 m/s	0.0027 kg	0.3 J
ShortGolf ballz!	30 m/s	0.025 kg	11 J

Make a claim about which ball had the most energy when hit by a golf club. Support your claim with evidence from the experiment and scientific reasoning.

Answers will vary.

Example: The ShortGolf ballz! has the most energy when hit by the ShortGolf club, hitta!. The kinetic energy produced by the ShortGolf ball is 36x that of the ping pong ball (.3 J vs 11 J). Since the ShortGolf ball is specifically engineered to be hit by a club that is stronger and heavier, the mass and size play a role in the kinetic energy of the ShortGolf ballz!.

Module 8.0: Climate and Weather in Golf

A key is not applicable for this lesson.

Weather Cards

Tropical Maritime *Warm* *Humid* Example location: Southeast (Florida and Georgia)	**Polar Maritime** *Cool* *Humid* Example location: Northeast and Northwest (Maine and Washington)
Polar Continental *Cool* *Dry* Example location: Central Canada	**Tropical Continental** *Warm* *Dry* Example location: Southwest (Arizona and New Mexico
Arctic Continental *Cool* *Dry* Example location: Northern Canada	

Scotland

Scotland Annual Average Climate

Averages	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rainfall (mm)	93	67	67	53	54	58	71	80	82	96	93	95
Temp (°C)	3.4	3.5	4.8	6.8	9.5	12	13.9	13.7	11.6	8.7	5.7	3.6
Min Temp (°C)	0.9	0.8	1.9	3.3	5.7	8.4	10.4	10.2	8.3	5.8	3.1	1
Max Temp (°C)	6.1	6.3	8	10.4	13.4	15.7	17.6	17.3	15	11.7	8.5	6.3

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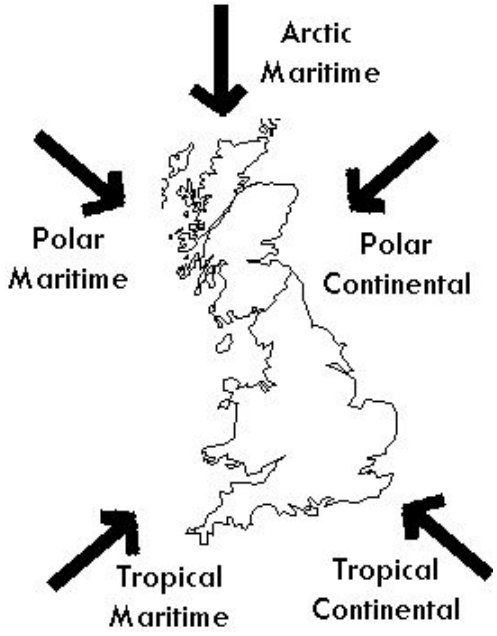

**http://www.coolgeography.co.uk/GCSE/Year11/Weather,Climate/Air%20masses/air_masses.htm*

Southern California

Los Angeles Annual Average Climate

Averages	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rainfall (mm)	82	87	61	26	6	2	1	7	12	32	62	
Temp (°C)	14.1	14.7	15.6	16.8	18.2	20.2	22.6	23	22.3	20.1	17.2	14.6
Min Temp (°C)	9.1	9.8	10.6	11.9	13.6	15.4	17.3	17.7	17	14.8	11.8	9.5
Max Temp (°C)	19.1	19.6	20.4	21.7	22.7	25	27.9	28.4	27.7	25.3	22.7	19.7

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Polar
Maritime
Polar
Continental
Tropical
Continental
Tropical
Maritime