LESSON TITLE: MYSTICAL MUSKET BALLS

GRADE/AUDIENCE:

- 7th -9th grade students (depending on the level and expectations).

STATE STANDARDS:

- Graph points on the coordinate plane to solve real-world and mathematical problems.
- Know the formulas for the area and circumference of a circle and use them to solve problems; give an informal derivation of the relationship between the circumference and area of a circle.
- Know the formulas for the volumes of cones, cylinders, and spheres and use them to solve real-world and mathematical problems.
- Apply the Pythagorean Theorem to find the distance between two points in a coordinate system.

LESSON OBJECTIVES:

- Plot on graph paper and label the point as the invoice number (the musket ball number).
- Find the circumference, surface area, and volume of the musket balls.
- Correctly use the distance formula or Pythagorean Theorem.
- Speculate how the battle between the Pequot and the Englishmen went at Mistick Fort.

LESSON OBJECTIVES FOR YOUR STUDENTS:

- Students will correctly plot and label the placement of the musket balls with their invoice number from the battle at Mistick Fort.
- Students will correctly find the circumference, surface area, and volume of any given musket ball.
- Students will correctly identify the distance between two points either using the distance formula or the Pythagorean Theorem.
- Students will create a story to speculate how the Battle of Mistick Fort happened based on the placement and state of musket balls (dropped, impacted, or melted).

COMPELLING / GUIDING QUESTIONS:

- How does the placement and how the musket balls were found allow us and archeologists to speculate what happened at the battle of Mistick Fort?

- Why do you think archeologists gather this data?
- Why do we need to know how to correctly plot the musket balls to help us with this battle?
- Why do you think some of the musket balls were so far apart?

DESCRIPTION OF LEARNING TASKS / ACTIVITIES:

1. Students will be given the musket ball data from the battle of Mystic Fort (see attached). Students will fill out the attached chart with the information collected in steps 2 – 4.
2. Students will plot all of the points (musket balls) labeled by their invoice numbers on poster board sized graph paper.
3. Find the surface area, circumference, and volume of at least ten musket balls. Use the diameter in inches found with the Sivilich Formula.
4. Find the distance between at least ten pairs of points (musket balls).
5. Students will write a one page paper analyzing the plotted points. Students should keep in mind whether the musket balls were impacted, dropped, or melted to help analyze the battle ground of Mistick Fort. Students should also draw a recreation of what they thought the battle would have looked like when it happened. They can use the various resources listed to assist them in what they thought it could have looked like.

TIME NEEDED FOR LESSON: One 45 minute class with students doing homework.

MATERIALS, RESOURCES, TECHNOLOGY NEEDED:

- Calculators, rulers, computers or an equivalent, pens/pencils, paper.

PRIMARY OR SECONDARY RESOURCES (WORKS CITED):

- Mashantucket Pequot Museum & Research Center resources. Accessed at: http://www.pequotmuseum.org/Default.aspx
- https://www.facebook.com/pequotmuseum/timeline

PRIOR LEARNING, CONNECTIONS, STUDENT NEEDS OR INTERESTS, COMMON MISCONCEPTIONS:

Prior learning:

- Plotting points.
- Applying the distance formula or Pythagorean Theorem, depending on which is applicable.

- Applying the circumference, surface area, and volume formulas.
- Introduction of Pequot Indians and the Battle of Mistick Fort (depending on the age and the expectations of the instructor). The teacher could also have the students complete their own research depending on their age.

Student needs or interests:

- Students may individual instruction to help get them started or throughout the project to answer any misunderstandings.
- Students may be paired up by the teacher or pick their own groups.
- Students that are interested in the History of the United States, specifically New England will be engaged and interested in this project.
- Students that know Mistick or have been there could also be more interested to know about this battle.
- Students that are interested in specific culture's objects and what they mean to their civilization will be interested.

Common Misconceptions:

- Students may not scale their graph correctly. For example, making each tick mark worth one which would not allow them to fit all of the points on the graph.
- Students may not understand the cardinal directions of the musket balls.
- Students may substitute the diameter for the radius in the various formulas.
- Students may not properly apply the various formulas correctly.
- Students may misunderstand the Battle of Mistick Fort.

SUGGESTED DIFFERENTIATIONS:

For struggling students:

- One-on-one instruction.
- Re-teaching.
- Lessen the requirements. For example, only find the surface area, circumference, and volume of 5 musket balls, similarly with the distance formula.
- Write a half page paper instead of a full page.
- The students may be paired up instead of work individually.

For enriched learning:

- Create a detailed drawing of the re-enactment of the battle of Mystic Fort.
- Find the proportion of weight to diameter of any number of musket balls.
- Speculate where arrow heads could be found on the battle ground and justify your response.

CROSS-DISCIPLINARY CONNECTIONS:

- Early American History
- Science
- English

FORMATIVE ASSESSMENT PROCESSES (INCLUDING STUDENT SELF-ASSESSMENT):

- The rubric that the teacher will use, as well as the students grading themselves.

Mystical Musket Balls Rubric			
Name:		Date:	
		Period:	
	Possible Points	Points Earned	Comments
Correctly plotted and label **ALL** of the musket balls by their invoice number		15	
Correctly finds the circumference of at least ten musket balls		10	
Correctly finds the surface area of at least ten musket balls		10	
Correctly finds the volume of at least ten musket balls		10	
Correctly finds the distance of at least ten pairs of musket balls		15	
Fully analyzes the musket ball placement and what the battle at Mystic Fort could have looked like		25	
Justifies with cited historical work of the analysis		15	
			Total Points: /100

Mystical Musket Balls Chart to fill out:

Round your answers to the nearest hundredth.

Mystical Musket Balls Chart		
	*Point #1	*Point # 2
Pair #1		
Pair #2		
Pair #3		
Pair #4		
Pair #5		
Pair #6		
Pair #7		
Pair #8		
Pair #9		
Pair #10		

*Identified by the invoice number

	Point # referenced by the invoice number	Radius	Circumference	Surface Area	Volume
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					

Mystical Musket Balls Chart

Musket Shot Data from the Battle of Mistick Fort

Inv. #	Unit	Quad	Impacted /Dropped /Melted	Weight (grams)	Diameter (inches): Sivilich Formula	Caliper Measurement	Difference in Diam.	Rounded Diam. (inches)
647.00	S262W113	NW	I	2.5	0.302934435			0.30
922.00	S238W32	NE	I	2.5	0.302934435			0.30
691.00	S206W30	NW	I	2.8	0.314597053			0.32
664.00	S217E20		I	3.1	0.325453693			0.33
744.00	S253W94	NW	I	3.2	0.328916227			0.33
665.00	S238E60	NE	I	3.6	0.342086661			0.34
666.00	S223E45	SW	M	3.7	0.345225246			0.35
697.00	S230E56	NE	I	3.8	0.348307778			0.35
643.00	S221E59	SE	M	3.9	0.351336693			0.35
685.00	S243E37		I	3.9	0.351336693			0.35
700.00	S210W8		I	3.9	0.351336693			0.35
656.00	S315W48		I	4	0.354314264			0.35
743.00	S222W113	SE	I	4.2	0.360123728			0.36
644.00	S237E52	SE	M	4.3	0.362959464			0.36
669.00	S222W23	SW	I	4.5	0.368501685			0.37
696.00	S229E50	NE	M	4.5	0.368501685			0.37
667.00	S227E49	SW	I	5.8	0.401031024			0.40
677.00	S225E5	SW	I	6.5	0.41655571			0.42
684.00	S219E48	SW	I	6.6	0.418681031			0.42
686.00	S222E37	NE	I	6.6	0.418681031			0.42
689.00	S234E40	NW	M	6.6	0.418681031			0.42
662.00	S234E51	SW	I	6.8	0.422868119			0.42
683.00	S220E53	SW	I	6.8	0.422868119			0.42
698.00	S228E52	NE	I	6.9	0.424930923			0.43
641.00	S246E36	NE	M	7.1	0.428997495			0.43
663.00	S234E51	SW	I	7.1	0.428997495			0.43
646.00	S294E22	NW	I	7.3	0.432988398			0.43
651.00	S271W19	NE	I	7.8	0.442656495			0.44
694.00	S219E31	SE	M	7.9	0.444540162			0.45
681.00	S218W9	NE	M	8.26	0.451192622			0.45
681.01	S218W9	NE	M	8.26	0.451192622			0.45
674.00	S217E50	NE	I	8.4	0.453727465			0.45
695.00	S224E40		M	8.4	0.453727465			0.45
652.00	S227E53	SE	D	8.6	0.457300269	0.4675	-0.0101997	0.46
640.00	S237W27		I	8.7	0.459065925			0.46

680.00	S215E45	NW	I		8.7	0.459065925			0.46
679.00	S217E6	NE	D		9.1	0.465996267	0.49	-0.0240037	0.47
639.00	S224W1	NW	M		9.2	0.467696998			0.47
678.00	S225E1	NW	D		9.3	0.46938545	0.4915	-0.0221146	0.47
688.00	S217E1	SW	D		9.5	0.472726384	0.494	-0.0212736	0.47
673.00	S229E7	NW	M		10	0.480878441			0.48
653.00	S292W64	SW	I		10.1	0.482476055			0.48
659.00	S244E45	NW	M		10.1	0.482476055			0.48
676.00	S230E5	NW	I		8	0.446408	0.475	-0.028592	0.48
648.00	S244E21	NE	D		10.2	0.484063159	0.48	0.0040632	0.48
672.00	S225W35		I		11.1	0.497900963			0.50
637.00	S234E90	NW	D		11.2	0.499391693	0.47	0.0293917	0.50
650.00	S272W20	SE	I		11.2	0.499391693			0.50
668.00	S239E5	SE	D		11.3	0.500873576	0.49	0.0108736	0.50
671.00	S224W25	SW	D		6.2	0.410045959	0.496	-0.085954	0.50
642.00	S224E56		M		11.9	0.509586163			0.51
645.00	S224E53	SW	I		12.7	0.520758715			0.52
681.00	S218W9	NE	M		15.34	0.55459646			0.56
1420.00	S264E83	SE	M		16.05	0.563024101			0.56
1420.01	S264E83	SE	M		16.05	0.563024101			0.56
657.00	S260W80	NE	I		17	0.573920336			0.57
699.00	S237E53	NW	I		17.1	0.575043471			0.58
655.00	S243E49	NE	M		21	0.615802912			0.62
682.00	S215E7	SE	M		21	0.615802912			0.62
690.00	S210W12	SE	D		23.3	0.637510409	0.633	0.0045104	0.64
675.00	S224E0	NW	I		25.2	0.654388241			0.65
			D		25.8	0.659541117	0.646		0.65
			D		29.5	0.689672081			0.69
687.00	S213E23	SW	D		29.8	0.692002072			0.69
638.00	S215E3	SW	D*		30.5	0.697378552			0.70
661.00	S264E103	SE	I		31	0.701168727			0.70
670.00	S239W26	NW	I		33.4	0.718815548			0.72
649.00	S260W24	NE	I		42	0.775863051			0.78