Lesson 1: Model of the MMS Satellite

This lesson will allow students to build a scale model of the MMS ***satellite*** and investigate the geometric properties.

Objectives:

- Build a three dimensional scale paper model of one of the MMS satellites.
- Calculate the octagonal area of the top and bottom of the satellite, given the measurements from the satellite.
- Compare the octagonal cross section area of the satellite with the circular cross section area of the launch vehicle to determine if the space craft will fit the cargo bay.

General Classroom Requirements:

Classroom Space Requirements:

The first lesson requires the students be able to work in groups to construct a model of the MMS Satellite. It will be better to have a room with tables if possible, or move desks in a circle.

Computer/Internet Station Requirements: The lesson requires students to access websites. This can be done individually, in groups of two or three or together as a class with a computer and projector. A whole class activity using a computer and a projector is recommended for the engage part of the lesson. An alternative would be to allow each student or group of students to explore the websites on their own and fill out a K-W-L chart as a group. For the explain part of the lesson, it is recommended that the students either have a computer or work in pairs on a computer to write their report.

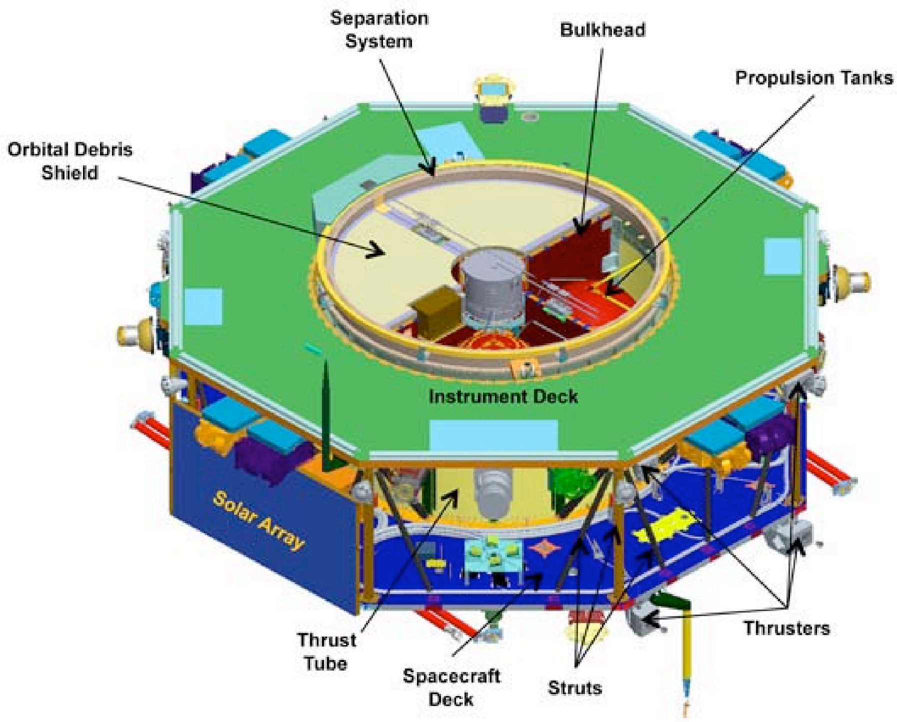
Time:

Engage Activity:	15 minutes
Explore Activity:	30 minutes
Explain Activity:	45 minutes
Elaborate Activity:	30 minutes
Evaluate Activity:	15 minutes

Total Time: 2 hours 15 minutes (Can break activities over multiple class sessions)

Content Background:

Each satellite has an octagonal shape that is approximately 3.5 meters wide and 1.2 meters high. The satellites spin at 3 ***revolutions*** per minute (RPM) during science operations. There are eight ***deployable booms*** per satellite: four 60 meter wire booms in the ***spin plane*** for electric field sensors, two 12.5 meter antennae booms in the ***axial plane*** for electric field sensors, and two 5 meter antennae booms in the spin plane for ***magnetometers***.



More information can be found at Websites for Lesson 1
http://mms.gsfc.nasa.gov/epo_math_guide.html

Lesson Plan

Engage
(15 Minutes)

For this part of the lesson, the students will learn about how satellites are designed and built.

Materials:
Computer
Projector or Smart Board
K-W-L charts on white board
Websites for Lesson 1 http://mms.gsfc.nasa.gov/epo_math_guide.html

The Activity: MMS Mission Pre-assessment
Get started by going to the MMS Mission website for teachers and students (link above) to explore what the mission is all about and for this lesson focus on how the satellites are built and their geometric shape and properties.

Work as a class to complete a “K-W-L” chart (Appendix A) to explore “What We Know”, “What We Want to Know”, and “What We Learned”. This will help students focus on and share what they already know about a subject. You, as the teacher, will become aware of the general knowledge basis that different students possess, and will be alerted to possible misconceptions that your students may have about particular topics.

One student can act as recorder and can compile a K-W-L chart for the class using the topics, **“What we know about how satellites are designed and built”** and **“What we wonder about the satellites being deployed to collect scientific data?”**

Complete all the lesson activities before completing the last section, **“What we learned about the size and shape of the MMS satellites.”**

Comprehension ***Knowledge***

Explore

(30 Minutes)

In this activity students will work in groups of four, each student building a model of the satellite. There are three types of models that can be built, paper, edible, or Lego. Each group of four students will represent the four satellites that will be launched into orbit together.

Materials:

Paper Model	Edible Model	Model of Lego Bricks
Flat paper model of satellite (Appendix B) Tape Colored Pencils or Crayons Scissors Ruler String, Thin Wire (Florist Wire) or Coffee Stirrers	Graham Crackers Frosting Hershey’s Chocolate bars Licorice whips Assorted small candies	Lego Kit Plans

The Activity:

The students will work in groups of four. Each student will build a model of one of the MMS Satellites and explore several aspects of the design including:

- the octagonal cross section
- the length of the antennas
- the placement of the satellites into the rocket for launching

They will also attach string (or licorice) that represents the length of the antennas to get a sense of scale. They will determine how large a rocket would have to be to launch four of the satellites. Follow the directions in Appendix B to build a model of the satellite.

Evaluate ***Synthesis*** ***Analysis***

Explain
(45 Minutes)

Materials:
Activity 1: Computing the Area of the Top and Bottom of the MMS Satellite (Appendix C)

The Activity:
Students should complete the activity for computing the area of the octagonal top and bottom of the satellite. Students draw labeled diagrams that show how they computed the area of the top of the satellite and how it can fit into the circular hull of the launch vehicle.

Analysis → ***Application*** → ***Comprehension*** → ***Knowledge***

Elaborate
(30 Minutes)

The students will write a paragraph to add to a report about the shape of the satellites and how they are to fit into the circular rocket pay load bay.

Materials:
Computer for each student or student team (not necessary)

The Activity:
The students will create a report that outlines how the octagonal satellites are placed into the circular cargo bay of the launch vehicle.

Things to include in your report:

- Explain the shape of the MMS satellite
- Explain how the octagonal satellites fit into the circular cargo bay (draw pictures to illustrate)
- Explain how large the antennae are on the MMS satellite

Evaluate → ***Application*** → ***Comprehension*** → ***Synthesis***

Evaluate

(15 Minutes)

The Activity:
Encourage students to complete their own report about the MMS satellite to summarize what they now know about the satellite and present them. The teacher will circulate while the students are creating their reports giving help if necessary.

Sample rubric for grading lesson – Teacher should modify

	Model	**Activity 1**	**Report**	**Points Received**
Accuracy				/15
Effort Regarding Facts				/15
Effort Regarding Correct Grammar, Punctuation and Sentence Structure				/15
Following Instructions				/15
			Total Points:	/60

Evaluate ***Synthesis*** ***Knowledge***

Extension Activity:
There are three versions of models made of Lego bricks available, one that includes the instruments on the satellite. http://mms.gsfc.nasa.gov/epo_mms_lego_model.html

Try the **SpaceMath@NASA Supplementary Problem #4 The Volume and Surface Area of an Octagonal MMS Satellite** at the end of this Guide.

Lesson 2: Launch of the Satellites

This lesson will give students an overview of the launch vehicle that will take the MMS satellites into space. They will look at some sample launch data and use algebra to compute the speed of the rocket.

Objectives

- Compute the speed of the launch rocket, given a data chart of time vs. distance data from lift-off.

General Classroom Requirements:

Classroom Space Requirements: No additional requirements.

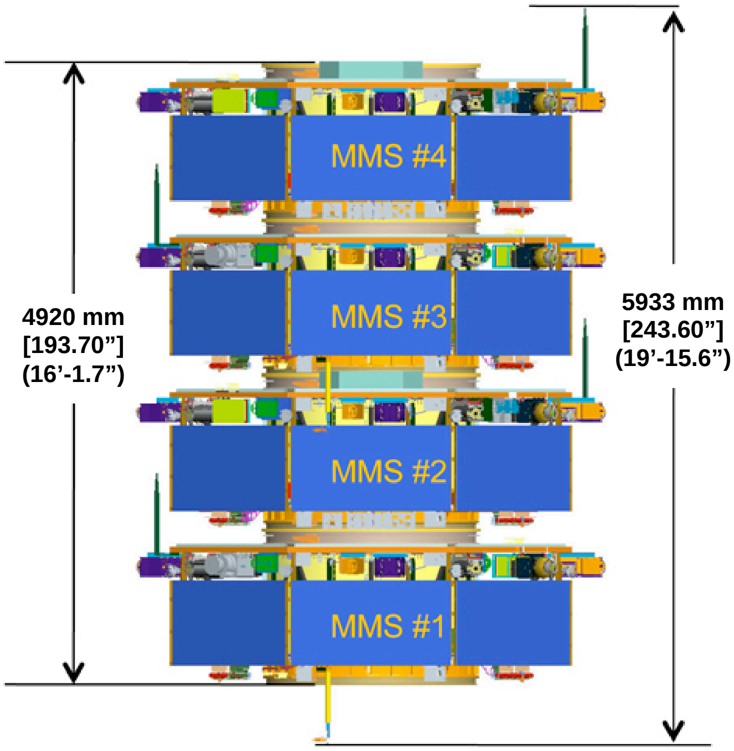
Computer/Internet Station Requirements: The lesson requires students to access websites. This can be done individually, in groups of two or three or together as a class with a computer and projector. A whole class activity using a computer and a projector is recommended for the engage part of the lesson. An alternative would be to allow each student or group of students to explore the websites on their own and fill out a K-W-L chart as a group. For the explain part of the lesson, it is recommended that the students either have a computer or work in pairs on a computer to write their report.

Time:

Engage Activity: 15 minutes
Explore Activity: 30 minutes
Explain Activity: 45 minutes
Elaborate Activity: 30 minutes
Evaluate Activity: 15 minutes
Total Time: 2 hours 15 minutes (Can break activities over multiple class sessions)

Content Background:

The Atlas V 421 Rocket is the vehicle that will be used to take the MMS satellites into space. The Atlas V was developed as part of the US Air Force Evolved Expendable Launch Vehicle (EELV) program. The term expendable launch vehicle means each vehicle is only used once. The MMS satellites will launch from Cape Canaveral Air Force Station in Florida.



The Atlas ***rockets*** are dedicated to launching certain classes of satellite cargo into ***orbit***. The Atlas V 421 that will be used for the MMS Mission has a 4 meter diameter payload bay and has two strap-on solid rocket boosters. The solid rocket boosters are used to provide thrust in spacecraft launches from the launch pad. The four MMS satellites will be stacked in the Atlas V rocket ***payload bay*** as pictured here.

More facts about the rockets can be found at Websites for Lesson 2 at

http://mms.gsfc.nasa.gov/epo_math_guide.html

Lesson Plan:

Engage

(15 minutes)

For this part of the lesson, the students will learn about how rockets are used to launch ***spacecrafts***, like satellites or ***planetary probes***, into space.

Materials:
Computer
Projector or Smart Board
K-W-L charts on white board
Websites for Lesson 2 http://mms.gsfc.nasa.gov/epo_math_guide.html

The Activity: MMS Launch Pre-assessment

Watch the launch of the rocket that can be found at the website listed above and discuss how the rockets take payloads into space.

Work as a class to complete a “K-W-L” chart to explore “What We Know”, “What We Want to Know”, and “What We Learned”. One student can act as recorder for the class to compile a K-W-L chart using the specific topics, **“What we know about how rockets are launched”** and **“What we wonder about how rockets are used to take things into space?”**

Complete all the lesson activities before completing the last section, **“What we learned about how the MMS satellites will be deployed into space using a rocket.”**

Comprehension ***Knowledge***

Explore

(30 minutes)

In this activity students will work in groups to collect facts about the specific rocket that will take the MMS satellites into space.

Materials:
Websites for Lesson 2 http://mms.gsfc.nasa.gov/epo_math_guide.html
Rocket Worksheet (Appendix D)

The Activity:
The students will visit the websites and collect facts about the Atlas V 421 launch rocket for the MMS Mission.

Synthesis

Explain

(45 minutes)

Students will complete an activity on the speed of the Atlas V rocket.

Materials:
Activity 2 – Computing the Speed of the Launch Rocket (Appendix E)

The Activity:
Students should complete the activity for computing the speed of the rocket at different time intervals. They will predict speeds using trending from the data given.

Evaluate ***Analysis***

Elaborate
(30 Minutes)

The students will write a paragraph to add to a report about the rocket that will take the MMS satellites into space.

Materials:
Computer for each student or student team (not necessary)

The Activity:
The students will create a report that outlines how large the rocket payload bay is and how the satellites fit in there. They should also describe how a rocket will be used to take the payload into space and how fast the rocket is going.

Things to include in your report:
- Explain where the satellites are placed in the rocket.
- Explain what the rocket uses for fuel.
- Explain how fast the rocket will be going when it is at certain distances from the earth.
- Other facts from the Rocket Fact Sheet

The students will write a report about the launch of the rocket to take the MMS satellites into space.

Evaluate | *Synthesis* | *Application* | *Comprehension*

Evaluate
(15 Minutes)

The Activity:
Encourage students to complete their own report about the MMS satellite launch to summarize what they learned about the rocket and present them. The teacher will circulate while the students are creating their reports giving help if necessary.

Sample Rubric for grading lesson – Teacher should modify

	Activity 1	Report	Points Received
Accuracy			/15
Effort Regarding Facts			/15
Effort Regarding Correct Grammar, Punctuation and Sentence Structure			/15
Following Instructions			/15
		Total Points:	/60

Evaluate | *Synthesis* | *Knowledge*

Extension Activity:
Have students construct a model of the rocket payload bay using things like poster board or large paper, which the satellites from Lesson 1 will fit into. Have groups of four students stack the satellites for launch inside their rocket payload bay.

Try the **SpaceMath@NASA Supplemental Problems**
#5 Some Statistical Facts about the MMS Atlas Rocket,
#6 Launching the MMS Satellite Constellation Into Orbit,
#7 The Magnetosphere Multi-Scale Payload – Up Close,
#8 Exploring the Atlas – V Launch Pad at Cape Canaveral and,
 # 9 The Acceleration Curve for the Atlas V MMS Launch
at the end of this Guide.

Lesson 3: The Satellites Flight Configuration

This Lesson will give students an overview of the how the MMS satellites fly through space to carry out their mission.

Objectives:

- Visualize the three dimensional tetrahedral flight configuration of the four satellites in the mission using graphing techniques and models,
- Analyze, by graphing techniques, the changing shape of the tetrahedron as the satellites change position.
- Compute the volume of the tetrahedron based on the positions of the four satellites.

General Classroom Requirements:

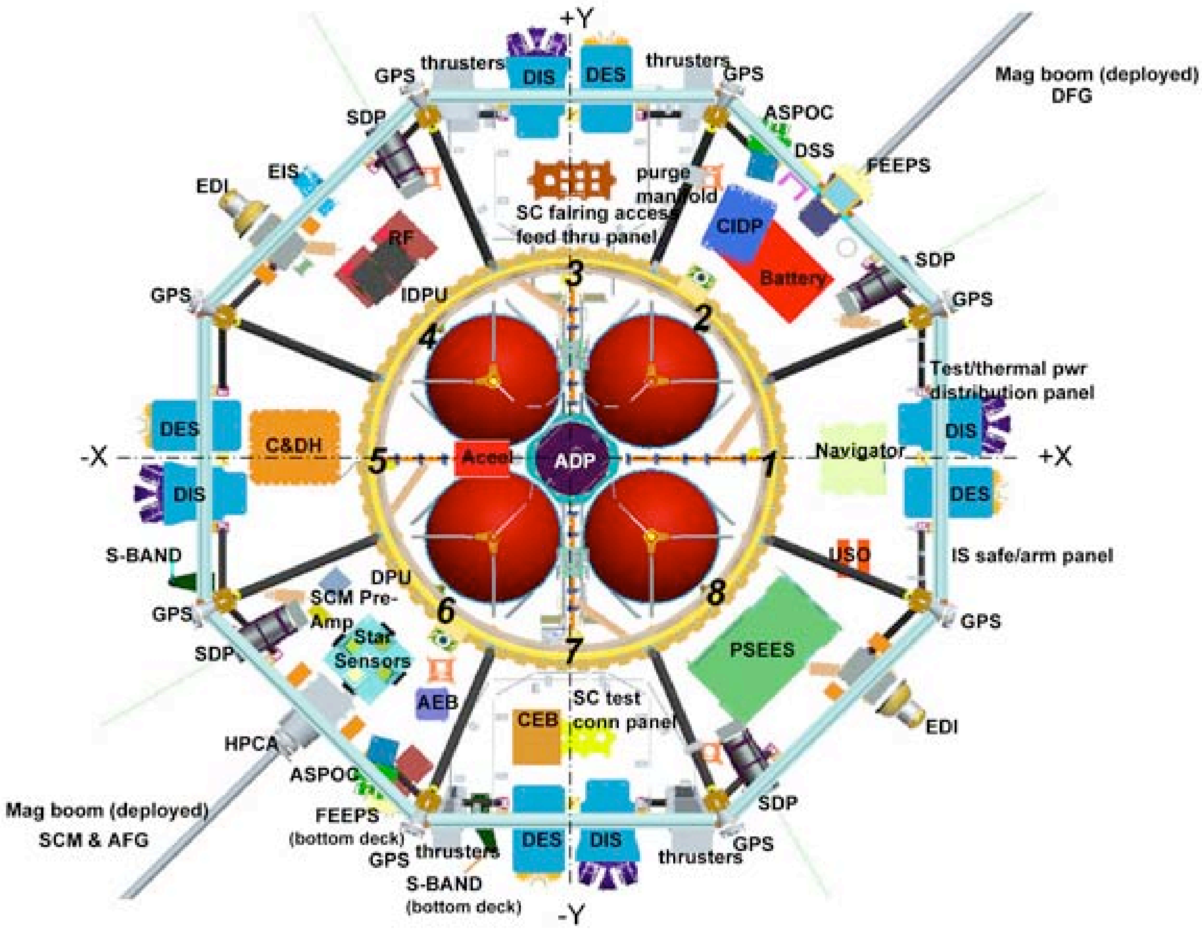
Classroom Space Requirements: No additional requirements.

Computer/Internet Station Requirements: The lesson requires students to access websites. This can be done individually, in groups of two or three or together as a class with a computer and projector. A whole class activity using a computer and a projector is recommended for the engage part of the lesson. An alternative would be to allow each student or group of students to explore the websites on their own and fill out a K-W-L chart as a group. For the explain part of the lesson, it is recommended that the students either have a computer or work in pairs on a computer to write their report.

Time:

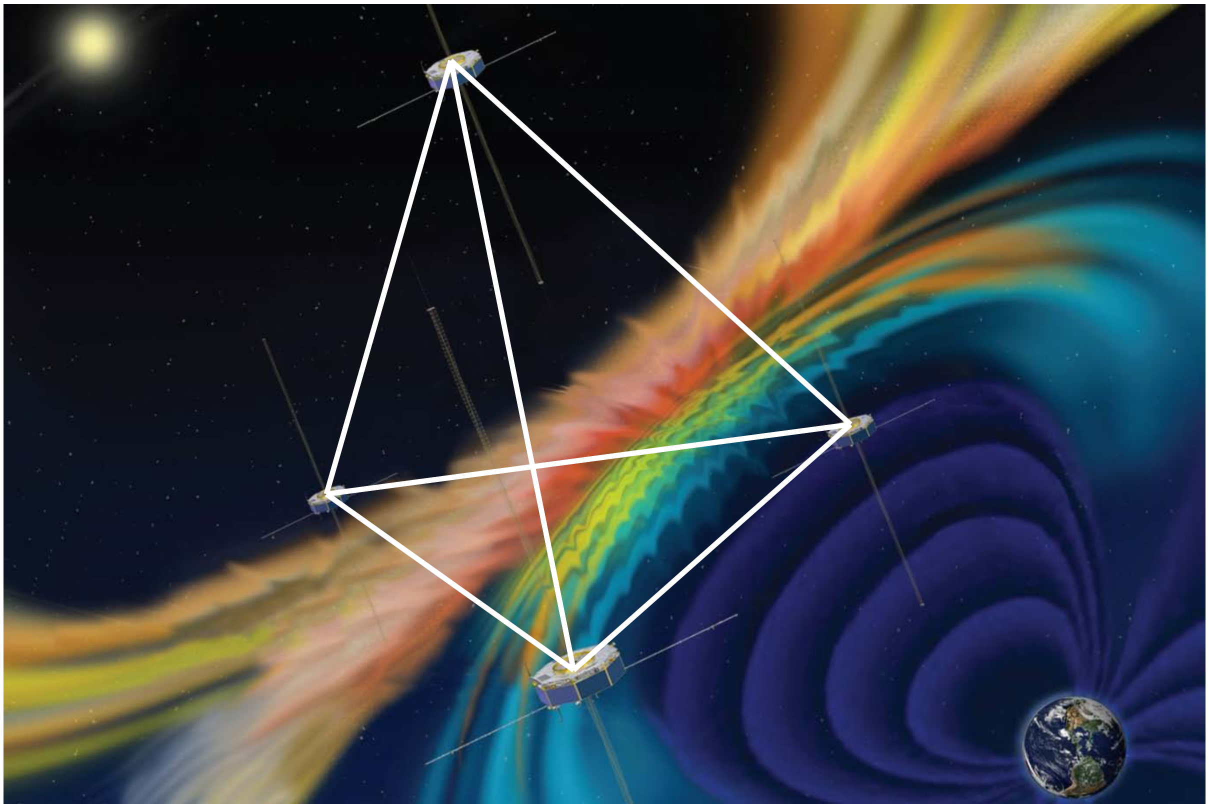
Engage Activity: 15 minutes
Explore Activity: 30 minutes
Explain Activity: 45 minutes
Elaborate: 30 minutes
Evaluate Activity: 15 minutes
Total Time: 2 hours 15 minutes (Can break activities over multiple class sessions)

Content Background:



The MMS satellites, once they leave the launch vehicle fly in formation. The satellites have a ***propulsion*** system with 12 ***thrusters***, sized to achieve both small formation maintenance maneuvers and larger maneuvers that move them into different orbits. The satellites' propellant and something called a mono-propellant blowdown system help them maintain their formation during their long mission through space. The propellant to help the satellites get into the correct position is contained in four titanium tanks per spacecraft.

The satellite flight configuration is a tetrahedron, with the four satellites as the four vertices of the tetrahedron. A tetrahedron is a polyhedron composed of four triangular faces. The tetrahedron is one kind of pyramid. In a regular tetrahedron, all four of the triangular faces are equilateral triangles (equal sides and equal angles). During the MMS mission, the shape of the tetrahedron changes as the satellites change positions.



The volume of a tetrahedron is given by the pyramid volume formula:

$$V = \frac{1}{3}Bh$$

where *B* is the area of the base and *h* the height from the base to the ***apex***. This applies for each of the four choices of the base.

Lesson Plan:

Engage
(15 Minutes)

MMS Flight Configuration Pre-assessment

For this part of the lesson, the students will watch a video of the orbit and formation of the MMS satellites as they fly through space and learn about satellite flight configurations.

Materials:
Computer
Projector or Smart Board
K-W-L charts on white board
Websites for Lesson 3 http://mms.gsfc.nasa.gov/epo_math_guide.html

The Activity: MMS Flight Configuration Pre-assessment

Watch a visualization of the MMS satellite's orbit and how the satellites fly in tetrahedral formation in the video on the website listed above.

"The movie initially shows the general orientation of the orbit with respect to the Earth, Moon, and Sun. It then zooms in to "ride" along with the spacecraft. We then zoom in even closer to show that there are actually four spacecraft flying in a tetrahedral formation.[1]"

Watch the video of the satellites flying in formation. One student can act as recorder and can compile a KWL chart for the class using the topics, **"What we know about how satellites fly in formation"** and **"What we wonder about the MMS satellites' formation"**

Complete all the lesson activities before completing the last section, **"What we learned about how the MMS satellites fly in a three dimensional formation to accomplish their mission."**

Comprehension ***Knowledge***

[1] http://mms.gsfc.nasa.gov/videos_animations.html

Explore
(30 minutes)

In this activity students will work in groups to collect facts about the other types of satellites and satellite configurations in space.

Materials:
Websites for Lesson 3
Formation Flying Worksheet (Appendix F)

The Activity:
The students will visit websites and collect facts about different types of satellites that fly in formation.

Synthesis

Explain
(45 minutes)

Materials:
Activity 3: Computing the Volume of the Flight Configuration (Appendix G)
Tape
Dot paper

The Activity:
Students will compute the volume of the tetrahedron that the four satellites make as they fly in their flight configuration. They will investigate how the volume of the tetrahedron changes as the satellites change positions.

Evaluate ***Synthesis*** ***Analysis***

Elaborate
(30 Minutes)

The students will write a section for their report about the flying formation of the MMS satellites in space.

Materials:
Computer for each student or student team (not necessary)

The Activity:
The students will create a report that outlines how the MMS satellites fly in a tetrahedral formation through space.

Things to include in your report:

- Give some examples of different satellites and explain how the different satellites fly in formation
- Explain the shape of the MMS satellite flight formation from the information you gained from the video and your activity
- Explain how the satellites can change position in space
- Explain how the volume of the flight configuration shape changes when the satellites change position (draw pictures to illustrate)

Evaluate | ***Synthesis*** | ***Application*** | ***Comprehension***

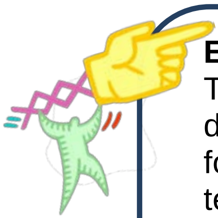
Evaluate
(15 Minutes)

The Activity:
Encourage students to complete their own report about the MMS satellite flight configuration. The teacher will circulate while the students are creating their reports giving help if necessary.

Sample Rubric for grading lesson – Teacher should modify

	Activity 1	Report	Points Received
Accuracy			/15
Effort Regarding Facts			/15
Effort Regarding Correct Grammar, Punctuation and Sentence Structure			/15
Following Instructions			/15
		Total Points:	/60

Evaluate | ***Synthesis*** | ***Knowledge***



Extension Activity:
Teams of four students could use the scale models they built for Lesson 1 and use dowel rods or coat hanger wire to assemble these scale models into a tetrahedral formation and hang in the classroom like a mobile. Students could also build a tetrahedral kite, have them look for instructions for this on the internet.

Try the **SpaceMath@NASA Supplementary Problem #1 The Orbit of the MMS Satellite Constellation** and **#2 The Orbit of the MMS Satellite Constellation** at the end of this Guide.

Lesson 4: Powering the Satellite (Solar Panels)

This lesson will give students an understanding of how much power can be generated by the solar panels on the MMS Satellite.

Objectives:

- Calculate the surface area of the panels that are exposed to the sun for various positions of the satellite, given the dimensions of the solar panels,
- Calculate the power generated by the solar panels for various positions of the satellite, given the dimensions of the panels.
- Organize and write a report about the satellites in the MMS Mission that contains information from the fours lessons, after completing the exercises for the unit.

General Classroom Requirements:

Classroom Space Requirements: No additional requirements.

Computer/Internet Station Requirements: The lesson requires students to access websites. This can be done individually, in groups of two or three or together as a class with a computer and projector. A whole class activity using a computer and a projector is recommended for the engage part of the lesson. An alternative would be to allow each student or group of students to explore the websites on their own and fill out a K-W-L chart as a group. For the explain part of the lesson, it is recommended that the students either have a computer or work in pairs on a computer to write their report.

Time:

Engage Activity:	15 minutes
Explore Activity:	30 minutes
Explain Activity:	30 minutes
Elaborate Activity:	30 minutes
Evaluate Activity:	15 minutes

Total Time: 2 hours (Can break activities over multiple class sessions)

Content Background:

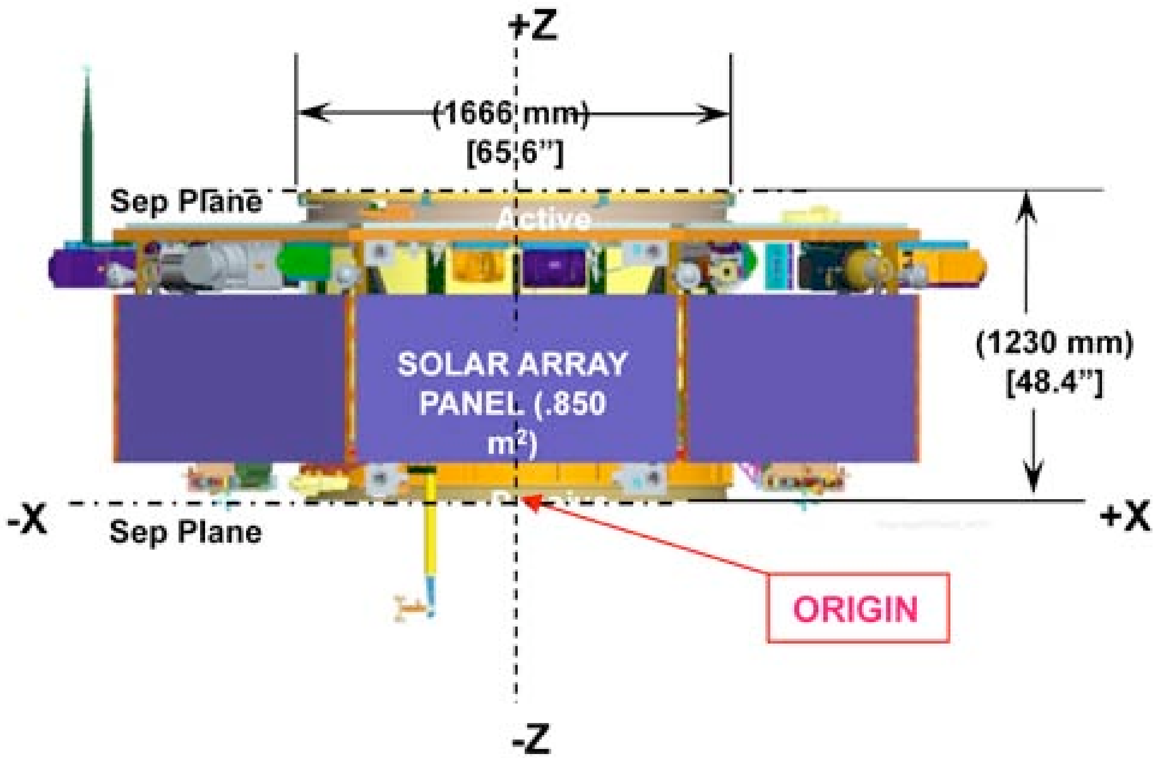


Figure 1: Satellite Solar Array Panel

Electrical power is needed to run many of the instruments and systems on the satellites. The satellites use ***solar energy*** to generate electricity to run their systems. The electrical power on each MMS Satellite is supplied from eight identical body-mounted solar array panels. Some of the power is also stored in on-board batteries. The batteries are sized to provide power during the four hour ***eclipses*** where the satellite would not be exposed to the Sun.

The table below shows some common appliances around your house and how much electricity they take to use. As you do the activities to see how much power can be produced by the solar panels, you can see in the table how much each of these would take to run by comparison.

Table 1: Example Power Usage Chart

Power Usage Charts for Appliances	Running Watts
Refrigerator	500
Microwave Oven	1200
Television	500
Personal Computer	700
Fan	250

Lesson Plan:

Engage
(15 minutes)

For this part of the lesson, the students will learn how solar panels can convert sun light into electricity.

Materials:
Computer
Projector or Smart Board
K-W-L charts on white board
Websites for Lesson 4 http://mms.gsfc.nasa.gov/epo_math_guide.html

The Activity: MMSSolar Power Pre-Assessment

Look at the NASA web page above that explains how light is converted into electricity. One student can act as recorder and can compile a K-W-L chart for the class using the topics, **"What we know about solar power"** and **"What we wonder about how a spacecraft could use solar power."**

Complete all the lesson activities before completing the last section, **"What we learned about how much power is generated by the solar array panels on the MMS satellite."**

Comprehension ***Knowledge***

Explore
(30 minutes)

In this activity students will work in groups to find examples of other NASA spacecraft and vehicles that use solar power. Have different students or groups of students investigate different NASA mission websites to collect information on the fact sheet. After about 10-15 minutes for gathering information and finding examples, student report on what they or their group found to the rest of the class.

Materials:
Spacecraft Solar Panel Worksheet (Appendix H)
Websites for Lesson 4 http://mms.gsfc.nasa.gov/epo_math_guide.html

The Activity:
The students will visit the websites and collect facts about the spacecraft that use solar power. If they are using a computer they could bookmark or collect pictures of spacecraft to show different configurations of the solar panels or draw diagrams to show what they saw to share with the class.

Synthesis

Explain

(30 minutes)

Materials:
Activity 4 – Computing the Electrical Power Generated by the Solar Panels (Appendix I)
Scissors

The Activity:
Students will complete the activity that allows them to find the range of power that will be generated by the solar array panels on each of the MMS Satellites.

Evaluate ***Synthesis*** ***Analysis*** ***Application*** ***Comprehension***

Elaborate

(30 Minutes)

The students will write a section for their report about the solar power generated by the MMS satellites in space.

Materials:
Computer for each student or student team (not necessary)

The Activity:
The students will create a report that outlines how the MMS satellites' solar panels generate power to run the systems of the spacecraft.

Things to include in your report:

- Give examples of different NASA spacecrafts and vehicles that use solar power.
- Discuss the different configurations of solar array panels on the spacecrafts and vehicles.
- Explain how many solar panels a MMS satellite has and how they are located on the spacecraft.
- Explain how many sides can be facing the sun at one time and the range of power that can be generated by each spacecraft.

Evaluate ***Synthesis*** ***Analysis*** ***Application*** ***Comprehension***

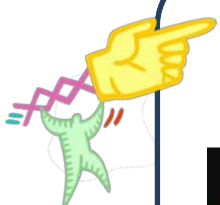
Evaluate
(15 Minutes)

The Activity:
Encourage students to complete their own report about the MMS satellite's solar power. The teacher will circulate while the students are creating their reports giving help if necessary.

Sample Rubric for grading lesson – Teacher should modify

	Activity 1	Report	Points Received
Accuracy			/15
Effort Regarding Facts			/15
Effort Regarding Correct Grammar, Punctuation and Sentence Structure			/15
Following Instructions			/15
		Total Points:	/60

Evaluate ***Synthesis*** ***Knowledge***



Extension Activity:
Have students look up the types of systems used on the MMS satellite and investigate how much energy each system would take to run.

Try the **SpaceMath@NASA Supplementary Problem #3 MMS Satellites and Solar Power** at the end of this Guide.

lProject Summary MMS Tic-Tac-Toe

Purpose:
To engage students with the material in a meaningful way to further explore personal interests regarding the MMS project.

Activity:
Students are to choose three activity squares which work to form a straight line diagonally, vertically or horizontally through the center square. The center square, ***Student Choice Activity***, is a required task and is developed by the student and completed with prior approval from the teacher.

Completed Tic-Tac-Toes Project:

- Tic-Tac-Toe Cover Sheet
  (Includes student name, date, title, and highlighted project choices.)
- Tic-Tac-Toe Rubric
- Activity 1 Components
- Activity 2 Components
- Activity 3 Components

Project Submission:
There are multiple modes of submission that teachers may choose from for their students to submit their final project. The following is a list of suggested resources and ideas that can be implemented for the submission process.

- Hand-written and/or Computer Printed Documents
- Electronic Files
  - Google Tools (http://www.google.com/educators/tools.html)
  - Edmodo (http://www.edmodo.com/)

Grading:
Student's projects will be graded using the *Magnetospheric Multiscale Mission: Tic-Tac-Toe Project Rubric.* Credit will be awarded based upon a point scale for each of the three activities if completed as it is described. It is the teacher's discretion as to how the student's final project grade will be weighted. *(e.g. Some teachers may decide to triple the student's final grade. Student's Points: 40/60 Final Grade: 120/180)*

Magnetospheric Multiscale Mission

Tic-Tac-Toe Project Guide

Directions: Choose three activity squares which work to form a straight line diagonally, vertically or horizontally through the center square. The center square, ***Student Choice Activity***, is a required task that you would like to complete as a part of your final project. The activity that you choose must have your teacher's prior approval. Using a highlighter or colored pencil please shade the squares denoting the project choices you have made.

Write Using a current events article (online or print) regarding satellites write a one-page report summarizing its contents and how it relates to what you have learned while studying about the MMS Mission.	***Develop*** Develop an informational brochure outlining the mission.	***Create*** Choose a topic relating to satellites and create a poster that accurately represents and explains the topic.
Discuss Discuss the purpose of satellites including why they are used to collect scientific data. You may present this information in the form of a slideshow, poster, advertisement, or a written document.	***Student Choice Activity*** *(Teacher Approval Required)*	***Construct*** Construct a 3-dimensional model of the MMS Satellite using a 3D online tool like Google SketchUp. Label key elements of the satellite.
Compose Compose a rap or a song reviewing the events of the MMS Mission.	***Experiment*** Using different polygons, experiment to find the relationship between the number of sides and the amount of solar power each would be able to collect. Compare the figures and how much energy each would produce for the satellite, then present your findings in a MS Power Point presentation.	***Generate*** A video that tells your friends about the MMS mission and what you have learned. Post this to a place where other students can view it to learn about the MMS mission.

Student Choice Activity:

____

____

Approval: ___________(Teacher Initials)

Magnetospheric Multiscale Mission

Tic-Tac-Toe Project Rubric

*Name:*________________________ *Period:*________

*Date:*__________

	5	4	3	2	1
Accuracy	All information is correct. No errors are found.	Most information is correct. Only 1 or 2 errors found.	Some information is correct. Between 3 and 5 errors found.	Little information is correct. 5 or more errors found.	No information is correct.
Content	Content is exceptional and relevant to the topic.	Content is relevant to the topic.	Some content is relative to the topic.	A small amount of content is relative to the topic.	Effort is not relevant to the topic.
Presentation	Presentation is creative and well-organized.	Good effort is made to present information in a neat and creative way.	Some effort was involved in the presentation.	Little effort was involved in the presentation.	No effort was involved in the presentation.
Following Instructions	All instructions are followed completely. No aspect of the activity contradicts the instructions.	Most instructions are followed completely. Only one aspect of the activity contradicts the instructions.	Some instructions are followed completely. Two aspects of the activity contradict the instructions.	Few instructions are followed completely. Three aspects of the activity contradict the instructions.	Instructions were not followed completely. More than three aspects of the activity contradict the instructions.

	Activity 1	**Activity 2**	**Activity 3**	**Points Received**
Accuracy				/15
Effort Regarding Facts				/15
Effort Regarding Presentation				/15
Following Instructions				/15
			Total Points:	/60

Glossary of Terms

apex	The tip, point, or vertex.
axial plane	An imaginary horizontal plane that divides the body into superior and inferior parts.
deployable booms	A folded structure that can be elongated when a spacecraft is in space. These structures form the building blocks of many larger space apertures, from solar sails to large antenna reflectors.
eclipses	An astronomical event that occurs when an astronomical object is temporarily obscured, either by passing into the shadow of another body or by having another body pass between it and the viewer.
magnetometers	A measuring instrument used to measure the strength or direction of magnetic fields.
orbit	The gravitationally curved path of an object around a point in space.
payload bay	Area on a spacecraft utilized to carry cargo.
planetary probes	A spacecraft carrying instruments intended for use in exploration of the physical properties of outer space or celestial bodies other than Earth.
propulsion	Movement caused by a force.
revolutions	The time taken by a celestial body to make a complete round in its orbit; the rotation of a celestial body on its axis.
rockets	A spacecraft that contains thrust from a rocket engine.
satellite	An object which has been placed into orbit by human endeavor to collect various types of information for research, communication, weather, etc.
spacecraft	A vehicle, vessel or machine designed for spaceflight.
solar energy	Radiant light and heat from the sun that has been harnessed by individuals to create an alternative source of power.

tetrahedron	A polyhedron composed of four triangular faces, three of which meet at each vertex. It has six edges and four vertices. The tetrahedron is the only convex polyhedron that has four faces.
thrusters	A small propulsive device used by spacecraft.