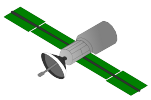
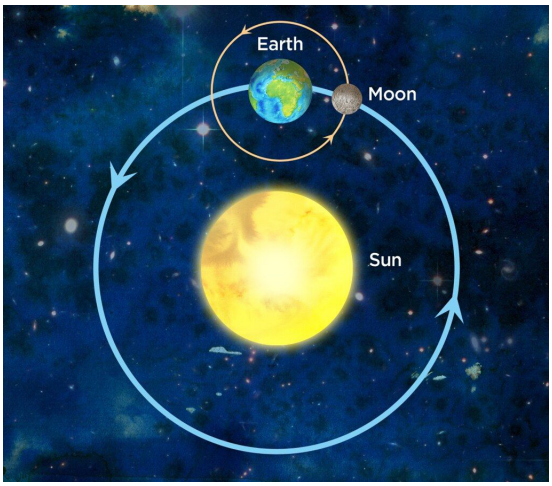
Satellites and CubeSats Teacher/Parent Guide



M.8.6.1, 8.6.2, 8.6.6/M.8.7.1, 8.7.2, 8.7.3



What is a satellite? A **satellite** is an object that orbits or revolves around a larger object. The moon is a satellite because it flies around the Earth, and the Earth is a satellite because it flies around the sun. Humans create and use satellites routinely, and they help us live our lives today.

So what is a CubeSat? A **CubeSat** is a very small satellite. A single-unit CubeSat has a volume of only **10^3 cubic centimeters**. However, many of these "units" can be **put together** to make one larger CubeSat. Common United States standard configurations range from one unit (or "1U") to a **54U**.

M.8.6.1, 8.6.2, 8.6.6, 8.7.1, 8.7.2, 8.7.3:

The process of designing CubeSats and their applications often involves many different uses of scientific notation, exponents, slopes, and ratios. Scientific notation saves time when calculating with very large or very small numbers and still allows for accurate calculations. Additionally, a large part of a CubeSat's mission is determining the slope at which it will be launched at, orbit at, and descend at. To practice these skills with real-world examples, print out the document labeled **Worksheet Eighth Grade Math by UASPACE.** There is an answer key attached at the end.

Name: _____
Teacher: _____
Date: _____

CubeSat Worksheet

This worksheet contains types or problems that engineers at UA face while designing and prototyping a CubeSat. Huge numbers and multiple-step equation simplification is all in a day's work. See if you have what it takes to be an engineer by solving the following problems. (M.8.6.1, 8.6.2, 8.6.6/M.8.7.1, 8.7.2, 8.7.3)

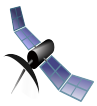
1) For CubeSat mission success, the team needs to find a slope of descent.
   a) For every mile that the satellite falls, it should move horizontally 2.5 miles. Show the slope of the descent using whole integers only.

   b) Heavy winds cause the satellite to move horizontally at half the rate as planned. Use the slope you calculated in Part a) and calculate the new slope of descent.

2) A new engineer is tasked to find out when the CubeSat from The University of Alabama will collide with the CubeSat from MIT. Given below are the equations of the lines that each CubeSat is travelling on. Determine the coordinates at which the collision will occur.

UA CubeSat:	y= -0.5x + 16
MIT CubeSat:	y= -0.3x + 19

3) A particular CubeSat will be in orbit for 100,000 hours. The CubeSat will move at about 7200 miles per hour. Calculate the distance that the satellite will cover using scientific notation.



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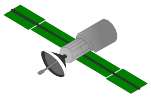
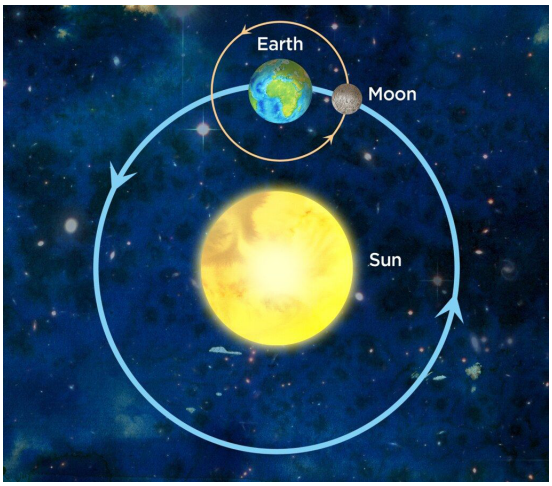


SCI.8.8.1, 8.8.5, 8.9.1, 8.9.5, 8.10.1, 8.10.4



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SCI.8.8.1, 8.8.5, 8.9.1, 8.9.5, 8.10.1, 8.10.4

Designing, testing, launching, using, and deorbiting a CubeSat is a great engineering challenge. Scientists and engineers have to use the laws of motion and laws of physics in their favor by knowing these laws inside and out. Many complicated equations have been derived from these laws to aid in the analysis of satellites.

Additionally, these laws incorporate many different characteristics of materials and forces. Believe it or not, there are just as many forces, if not more, in space as there are here on Earth! All of these forces need to be noted and incorporated into these equations. Mass and acceleration are the two biggest factors in these equations, along with velocity.

Now let's take a look at some of these laws that affect a CubeSat. **Worksheet Eighth Grade Science by UASPACE** allows you to explore this comparison. There is a key attached at the end.

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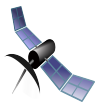
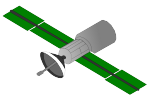


CubeSat: Laws of Motion



SCI.8.8.1, 8.8.5, 8.9.1, 8.9.5, 8.10.1, 8.10.4

For The University of Alabama, our CubeSat mission is to showcase NASA's drag sail technology in hopes to open doors in the future regarding safe de-orbiting. What makes this a unique challenge is the vast differences between space and Earth.
A CubeSat, like everything else, is subject to Newton's Laws of Motion, even in space. However, engineers and physicists have found clever ways to manipulate these laws without breaking them. NOTE: Some answers may be used twice, and some maybe not at all!

CubeSat Systems	**Answer**	**Cell Structures**
1. Every action or force has an equal and opposite reaction or force 2. The amount of matter in an object 3. The speed of an object in a given direction 4. An object at rest will remain at rest, and an object in motion will remain in motion, unless acted on by a force 5. The velocity of an object changes when it is subjected to an external force (Force = mass * acceleration) 6. The mass per unit volume	1. ___ 2. ___ 3. ___ 4. ___ 5. ___ 6. ___	A. Newton's First Law B. Newton's Second Law C. Newton's Third Law D. Inertia E. Density F. Mass G. Velocity H. Acceleration

BONUS: What term was NOT matched with a definition, and what is the definition of that term?

Name: _____
Teacher: _____
Date: _____

KEY: CubeSat Worksheet

These problems are very similar to the approximations made by the actual CubeSat design team here at UA! Try them out for yourself. Remember that CubeSats can be measured in terms of volume in "Units" or "U" - 10cm x 10cm x 10cm cubes, or 1000cm^3. (M.7.2.2, 7.9, 7.10, 7.22, 7.24)

1) For CubeSat mission success, the team needs to find a slope of descent.
   a) For every mile that the satellite falls, it should move horizontally 2.5 miles. Show the slope of the descent using whole integers only.

$$\text{Slope} = \frac{rise}{run}$$

$$\frac{-1}{2.5} \quad multiply\ by\ 2 \quad \frac{-2}{5}$$

   b) Heavy winds cause the satellite to move horizontally at half the rate as planned. Use the slope you calculated in Part a) and calculate the new slope of descent.

$$\frac{-2}{5} * \frac{1}{2} = \frac{-2}{10} = \frac{-1}{5}$$

2) A new engineer is tasked to find out when the CubeSat from The University of Alabama will collide with the CubeSat from MIT. Given below are the equations of the lines that each CubeSat is travelling on. Determine the coordinates at which the collision will occur.

UA CubeSat:	y= -0.5x + 16
MIT CubeSat:	y= -0.3x + 19

$$y = y,\ therefore\ -0.5x + 16 = -0.3x + 19$$

$$Get\ x\ on\ one\ side:\ -0.2x + 16 = 19$$

$$Get\ constants\ on\ the\ opposite: \quad -0.2x = 3$$

$$Simplify\ for\ x: \quad x = \quad -15$$

This x value when put into either equation will give you the correct y value for intersection.

$$y = \quad -0.3(-15) + 19$$

$$y = 23.5, \ so: \ (-15, \ 23.5)\ is\ the\ answer$$

3) A particular CubeSat will be in orbit for 100,000 hours. The CubeSat will move at about 7200 miles per hour. Calculate the distance that the satellite will cover using scientific notation.

To get the distance, multiply the miles/hour by the hours. This will eliminate the denominator in miles/hour and leave you with miles

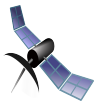
$$100,000\ hours \ = \ 10 * 10^4$$

$$7,200 = 7.2 * 10^3$$

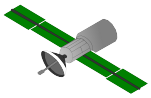
$$Add\ exponents\ together = 10^7$$

$$Multiply\ the\ numbers = 10 * 7.2 = 72$$

$$Simplify = 72 * 10^7 = 7.2 * 10^8\ miles$$



KEY: CubeSat: Laws of Motion



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CubeSat Parts	**Answer**	**Cell Structures**
1. Every action or force has an equal and opposite reaction or force 2. The amount of matter in an object 3. The speed of an object in a given direction 4. An object at rest will remain at rest, and an object in motion will remain in motion, unless acted on by a force 5. The velocity of an object changes when it is subjected to an external force (Force = mass * acceleration) 6. The mass per unit volume	1. _C_ 2. _F_ 3. _G_ 4. _A, D_ 5. _B_ 6. _E_	A. Newton's First Law B. Newton's Second Law C. Newton's Third Law D. Inertia E. Density F. Mass G. Velocity H. Acceleration

BONUS: What term was NOT matched with a definition, and what is the definition of that term?

Acceleration: The change in velocity of an object (faster, slower, directional)