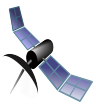
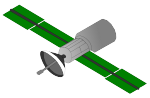
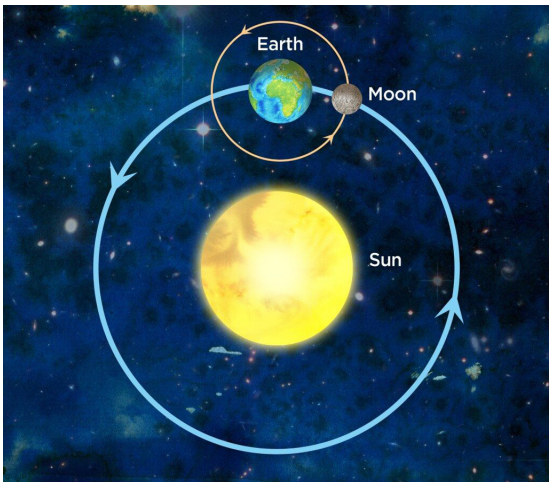


# Satellites and CubeSats Teacher/Parent Guide



M.7.2.2, 7.9, 7.10, 76.22, 7.24

What is a satellite? A **satellite** is an object that orbits, revloves, or flies around a larger object. The moon is a satellite because it flies around the Earth! And Earth is a satellite because it flies around the sun! But we can make satellites, too!

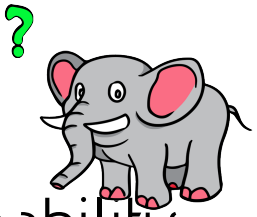



So what is a CubeSat? A **CubeSat** is a very small satellite. A single-unit CubeSat is only **10x10x10 centimeters**. However, many of these "units" can be **put together** to make one larger CubeSat. Common United States standard configurations range from one unit (or "1U") to a **54U**!

**M.7.2.2, 7.9, 7.10, 7.22, 7.24:**

The process of designing CubeSats often involves calculating what is needed for one sized CubeSat based off of another. Proportional relationships and simple algebraic equations can be used to estimate these relationships, forming real-world math problems. Another major element of mission design is estimating risk, often done by calculating the combined probability of a failure occurring between multiple events. To practice these skills with real-world examples, try **Worksheet Seventh Grade Math by UASPACE.** There is an answer key on pages 3 and 4.

Name: _____
Teacher: _____
Date: _____



# CubeSat Proportions and Probability

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) The team is trying to design a 12U CubeSat by scaling up a 3U CubeSat.
   a) Write a fraction showing the relationship between the 12U CubeSat and the 3U CubeSat

   b) Simplify this fraction to show how many times bigger the 12U CubeSat is compared to the 3U CubeSat.

2) Some engineers are trying to design a 12U CubeSat by scaling up a 3U CubeSat. If the 3U CubeSat has room for a 1U payload, and the amount of room for a payload scales with the size of the CubeSat, how much room does the 12U CubeSat have for a payload? Write and solve an equation for this problem.

3) Students have determined that more than one rectangular solar panels on the surface of the CubeSat's are going to need to have their perimeter outlined with thermal tape. If each panels has a width of 9cm and a length of 25cm, write a simple algebraic equation to determine the total perimeter of X number of panels.

4) If a CubeSat has a 90% chance of successfully completing its mission without any errors, write the probability of this success as a fraction, and then simplify it.

5) A different CubeSat is much better designed, and has many parts with very small chances of failure. If Part A has a 99% of working right, and Part B has a 95% chance of working right, what is probability that *both* Part A and Part B work right?

# KEY: CubeSat Proportions and Probability

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) The team is trying to design a 12U CubeSat by scaling up a 3U CubeSat.
   a) Write a fraction showing the relationship between the 12U CubeSat and the 3U CubeSat

$$\frac{12}{3}$$

   b) Simplify this fraction to show how many times bigger the 12U CubeSat is compared to the 3U CubeSat.

$$\frac{12}{3} = \frac{3}{1} = 3$$

2) Some engineers are trying to design a 12U CubeSat by scaling up a 3U CubeSat. If the 3U CubeSat has room for a 2U payload, and the amount of room for a payload scales with the size of the CubeSat, how much room does the 12U CubeSat have for a payload? Write and solve an equation for this problem.

$$\frac{12}{3} = \frac{x}{2} \; therefore \; 2 * (12) = 3 * x$$

$$Simplify \; to \; 24 = 3x, \; then \; \frac{24}{3} = x$$

$$Simplify \; to \; x = 8$$

3) Students have determined that more than one rectangular solar panels on the surface of the CubeSat's are going to need to have their perimeter outlined with thermal tape. If

each panels has a width of 9cm and a length of 25cm, write a simple algebraic equation to determine the total perimeter of X number of panels.

$$Since\ perimeter\ =\ 2 * length\ +\ 2 *\ width$$
$$The\ equation\ can\ be\ written\ was\ P = x(2l + 2w)$$
$$Or,\ with\ details\ from\ the\ problem,\ P = x(2 * 9 + 2 * 25)$$
$$And\ then\ simplified,\ P = x(18 + 50)$$
$$P = x(68) = 68x$$

4) If a CubeSat has a 90% chance of successfully completing its mission without any errors, write the probability of this success as a fraction, and then simplify it

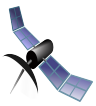
$$The\ Cubesat\ will\ work\ successfully\ \frac{90}{100}\ times$$
$$\frac{90}{100}\ simplifies\ to\ \frac{9}{10}$$

5) A different CubeSat is much better designed, and has many parts with very small chances of failure. If Part A has a 99% of working right, and Part B has a 95% chance of working right, what is the probability that *both* Part A and Part B work right?

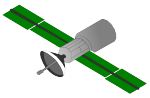
*The probability of two events both occurring can be found by multiplying the probabilities.*

$$Pboth\ = Pa\ * Pb = .99 * .95 = .9405\ =\ 94.05\%$$

*There is about a* 94% *chance that both Part A and Part B work correctly.*

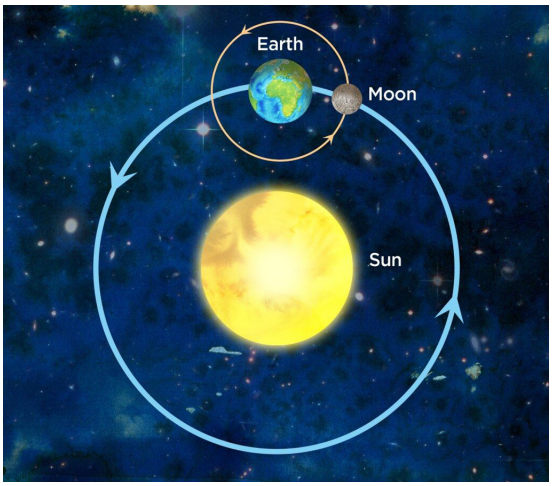


# Satellites and CubeSats Teacher/Parent Guide



SCI.7.31.1, 7.4.1, 7.5.1, 7.7.2, 7.7.3

What is a satellite? A **satellite** is an object that orbits, revloves, or flies around a larger object. The moon is a satellite because it flies around the Earth! And Earth is a satellite because it flies around the sun! But we can make satellites, too!




So what is a CubeSat? A **CubeSat** is a very small satellite. A single-unit CubeSat is only **10x10x10 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**!

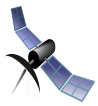
**SCI.7.7.2, 7.7.3:**

One of the most common modern uses of CubeSats is in large groups known as "constellations," which together can complete much bigger tasks than any one CubeSat could do alone. Some CubeSat constellations are used to photograph the entire earth several times per day! These photographs can be combined and compared to study many different things, but what they're most helpful in studying is things that can change rapidly. Larger satellites, depending on their orbit, often either photograph fewer areas less often, or are meant to observe one area at a time and then take time to be moved to a new location. A constellation of cubesats that images the entire earth multiple times a day allows fast-moving events to be observed!

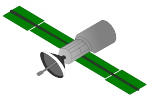
Some events that this ability is used to keep an eye on are wildfires and deforestation. Both of those things can be caught very early by software looking at differences between photographs of the same location at different times. This can help identify illegal logging in real time, and allow fires to be watched and contained before they grow out of control.

Now let's take a look at what actually goes into a CubeSat! A CubeSat is a little bit like a very big cell, full of structures that each have a specific job. **Worksheet Seventh Grade SCI.7.3.1 by UASPACE** allows you to explore this comparison. There is a key on page 2.

Name: _____
Teacher: _____
Date: _____



# CubeSat Systems



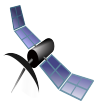
SCI.7.3.1, 7.4.1, 7.5.1

A CubeSat is a little bit like a very big cell, full of structures that each have a specific job. Can you match which cell structure each CubeSat part is *most* like?

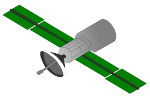
| CubeSat Systems | Answer | Cell Structures |
|---|---|---|
| 1. **Electrical Power Systems** - Manages the CubeSat's energy production; the powerhouse of the CubeSat | 1. ___ | A. Nucleus |
| 2. **Structure** - Everything else within the CubeSat is contained within the structure | 2. ___ | B. Cell Wall |
| 3. **Command and Data Handling** - Controls the CubeSat's activities and contains most of the code that tells it how to operate. | 3. ___ | C. Cell Membrane |
| 4. **Attitude Determination and Control** - Moves and points the CubeSat in space | 4. ___ | D. Cilia and Flagella |
| 5. **Payload** - The rest of the CubeSat stores this, and what is being stored can be very different depending on the CubeSat | 5. ___ | E. Mitochondria |
| 6. **Thermal Control** - Controls how heat enters and leaves the CubeSat | 6. ___ | F. Vacuole |

If one of these systems were to stop working, what would happen to the CubeSat as a whole? Pick two systems and describe what might happen to the rest of the CubeSat if they broke.

2.



# KEY: Sun Phases



SCI.7.3.1, 7.4.1, 7.5.1

A CubeSat is a little bit like a very big cell, full of structures that each have a specific job. Can you match which cell structure each CubeSat part is *most* like?

| CubeSat Parts | Answer | Cell Structures |
|---|---|---|
| 1. **Electrical Power Systems** - Manages the CubeSat's energy production; the powerhouse of the CubeSat<br>2. **Structure** - Everything else within the CubeSat is contained within the structure<br>3. **Command and Data Handling** - Controls the CubeSat's activities and contains most of the code that tells it how to operate.<br>4. **Attitude Determination and Control** - Moves and points the CubeSat in space<br>5. **Payload** - The rest of the CubeSat stores this, and what is being stored can be very different depending on the CubeSat<br>6. **Thermal Control** - Controls how heat enters and leaves the CubeSat | 1. _E_<br>2. _B_<br>3. _A_<br>4. _D_<br>5. _F_<br>6. _C_ | A. Nucleus<br>B. Cell Wall<br>C. Cell Membrane<br>D. Cilia and Flagella<br>E. Mitochondria<br>F. Vacuole |

If one of these systems were to stop working, what would happen to the CubeSat as a whole? Pick two systems and describe what might happen to the rest of the CubeSat if they broke.

If any system stopped working, the CubeSat would also stop working.
Systems:
Electrical Power Systems failing would cause the rest of the CubeSat to not get any energy.
Structure failing would cause the CubeSat to fall apart
Command and Data Handling failing would cause the CubeSat to not be able to do anything
Attitude Determination and Control failing would mean the CubeSat could no longer move and point, and might begin to spin or tumble out of control.
Payload failing would mean the CubeSat no longer has a purpose, and may also cause damage to other systems.
Thermal Control failing would cause the CubeSat to get too hot or too cold.