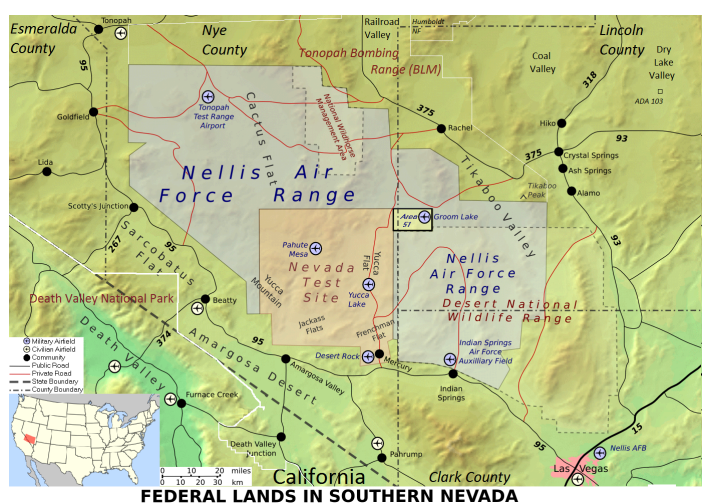


## Task Scenario

Located 120 miles north of Las Vegas, Area 51 is shrouded in mystery. Starting in 1955 the United States has been testing top secret aircraft at Area 51.



Location of Area 51

Source:

[https://en.wikipedia.org/wiki/File:Wfm\\_area51\\_map\\_en.png](https://en.wikipedia.org/wiki/File:Wfm_area51_map_en.png)



Secret aircraft tested at Area 51.

Source:

<https://nsarchive.gwu.edu/briefing-book/intelligence/2013-10-29/area-51-file-secret-aircraft-soviet-migs>

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Boeing YF-118G Bird of Prey

Source:

[https://en.wikipedia.org/wiki/Boeing\\_Bird\\_of\\_Prey#/media/File:Boeing\\_Bird\\_of\\_Prey\\_USAF.jpg](https://en.wikipedia.org/wiki/Boeing_Bird_of_Prey#/media/File:Boeing_Bird_of_Prey_USAF.jpg)

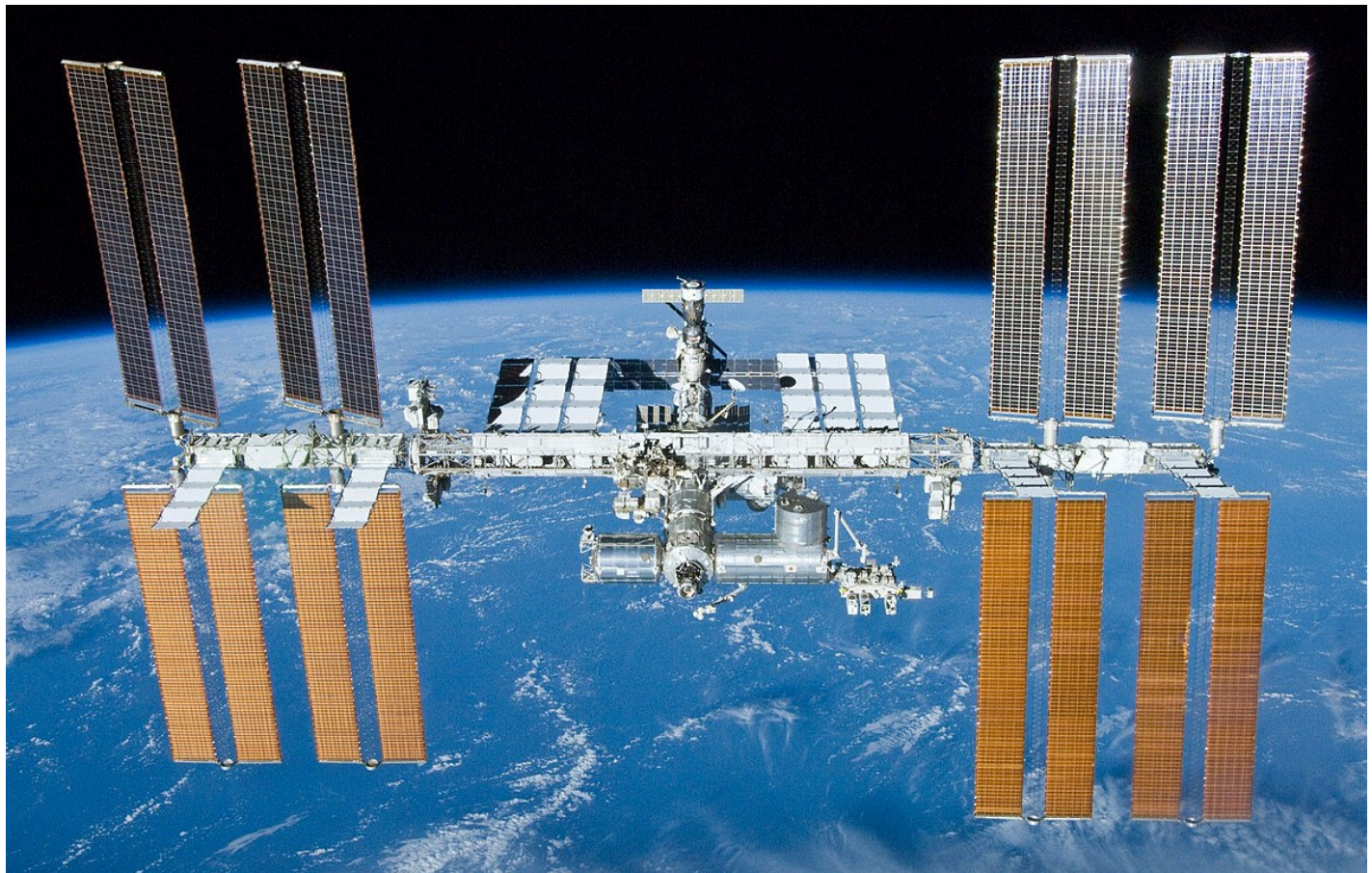


F-117 Nighthawk

Source:

[https://en.wikipedia.org/wiki/Lockheed\\_F-117\\_Nighthawk#/media/File:F-117\\_Nighthawk\\_Front.jpg](https://en.wikipedia.org/wiki/Lockheed_F-117_Nighthawk#/media/File:F-117_Nighthawk_Front.jpg)





The International Space Station (ISS) is a large spacecraft. It orbits around Earth. It is a home where astronauts live. The space station is also a science lab. Many countries worked together to build it. They also work together to use it. The space station is made of many pieces. The pieces were put together in space by astronauts.

Source: [https://en.wikipedia.org/wiki/International\\_Space\\_Station](https://en.wikipedia.org/wiki/International_Space_Station) and <https://www.nasa.gov/audience/forstudents/k-4/stories/nasa-knows/what-is-the-iss-k4.html>

*Task: You are an astronaut in the International Space Station. Area 51 is going to do some aerial maneuvers with two of their old test planes: the F-117 Nighthawk and the Boeing YF-118G Bird of Prey. Your job is to record this event from space. If the camera set up takes your crew about 20 minutes, will you be set up in time to record this event? Why or why not?*

## Question #1

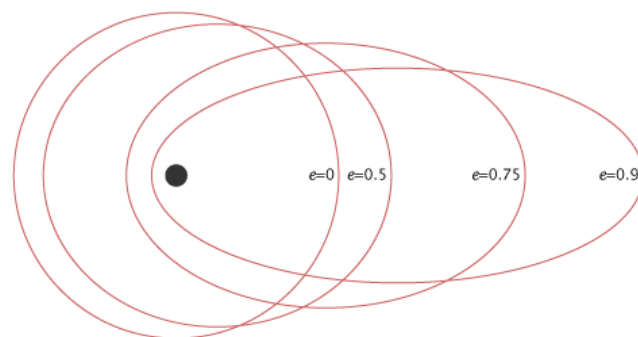
Student  
Stimulus/Prompt

### Kepler's 1st Law: Thinking about Eccentricity

The orbit of every planet is an ellipse with the Sun at one of the two foci. This also applies to satellites orbiting Earth.  $e$  (eccentricity) of an orbiting object is between 0 and 1. 0 being a perfect circle and 1 being close to a straight line. Eccentricity  $e = f/d$ , where  $f$  is the distance between foci of an ellipse, and  $d$  is the ellipse's major axis length. Source: <https://earthobservatory.nasa.gov/features/OrbitsCatalog>

1 being the most eccentric and 5 being the least eccentric, put these orbiting objects in order. Which of these orbits are the nearest to a circle?

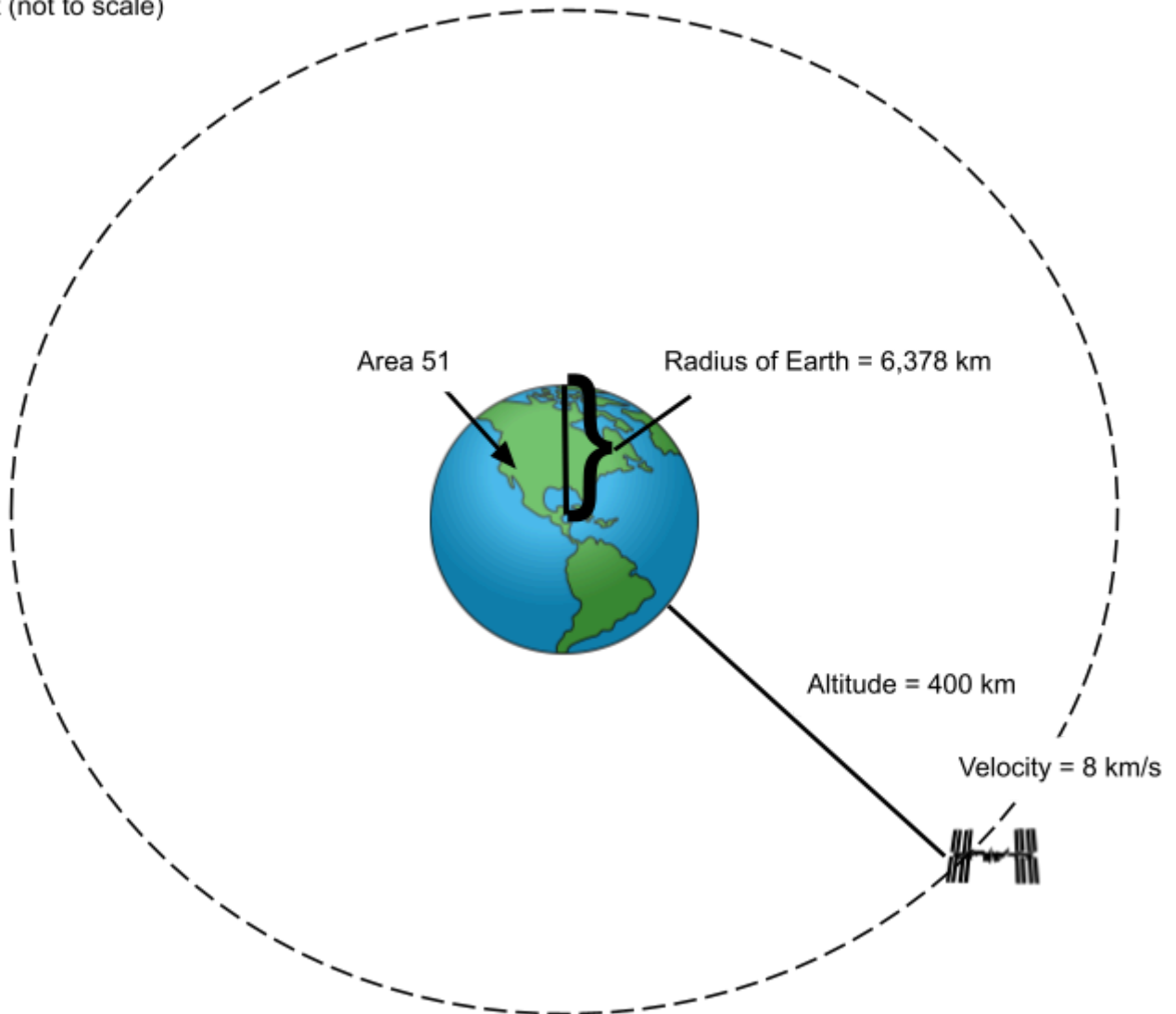
Orbiting Body	Eccentricity
Halley's Comet (heliocentric orbit)	0.97
Hubble Space Telescope (geocentric low earth orbit)	0.0003
Earth's Moon (geocentric orbit)	0.0549
Mercury (heliocentric orbit)	0.2056
International Space Station (geocentric low earth orbit)	0.0002489
Sirius Satellite Radio (geocentric Tundra orbit)	0.300
Jumpseat (geocentric Molniya orbit)	0.74



Source: <https://earthobservatory.nasa.gov/features/OrbitsCatalog>

Diagram: You will modify this diagram as you answer each of the questions.

ISS orbit (not to scale)



## Question #2

Student  
Stimulus/Prompt

### Kepler's 3rd Law: Calculating R (semi-major axis) & Circular Orbit

*The time required for a planet to make one revolution is called its "period of revolution" or "orbital period." It takes a little over 365 Earth days for our Earth to make one period of revolution (1 orbit).*

What is the radius of the ISS orbit in km? Show your work.

Remember:  **$R$  = radius of Earth + distance ISS is from Earth's surface**



	<p>Use this R value to calculate the distance the ISS travels around the Earth in one full orbit. Since the ISS travels around the Earth in a circular orbit, the distance the ISS travels is equal to the circumference C of its circular orbit. Show your work. Show this on the diagram.</p> <p>Remember: <b><math>C = 2\pi R</math> and <math>\pi = 3.14</math></b></p>
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Question #3	
Student Stimulus/Prompt	<p><b>Kepler's 3rd Law: Calculating Orbital Period</b></p> <p><i>The time required for a planet to make one revolution is called its "period of revolution" or "orbital period." It takes a little over 365 Earth days for our Earth to make one period of revolution (1 orbit).</i></p> <p>ISS has a velocity of about 8 km/second, how long does it take for the ISS to make one orbit. (The time it takes for an object to complete one full orbit is also known as the orbital period). Show your work. Display your answer in hours. Show this on the diagram.</p> <p>Remember: <b>speed (velocity) of ISS = distance ISS travels in one orbit / time</b>  <b>Time (orbital period) = distance ISS travels in one orbit / velocity of ISS</b></p>

Question #4	
Student Stimulus/Prompt	<p><b>Kepler's 3rd Law: Predicting</b></p> <p>Area 51 is <math>\frac{1}{3}</math> of an orbit away from ISS, it will take <math>\frac{1}{3}</math> of the orbital period to reach Area 51 to record the event. Calculate how long it will take the ISS to reach Area 51. Show your work. Display your answer in minutes. Show this on the diagram.</p> <p><b>Time it takes ISS to travel to Area 51 = Period / 3</b></p>

### Question #5

Student  
Stimulus/Prompt

#### Explanation

If the camera set up takes about 20 minutes, will the International Space Station astronauts be able to record the event at Area 51? Explain your answer providing evidence from each of the questions above.

Question 1:

Question 2:

Question 3:

Question 4:

### Question #6

Student  
Stimulus/Prompt

#### Extension

There is some space debris right in the ISS's path, should the ISS move into a lower or higher orbit? Explain your answer.