

TEACHER'S GUIDE

to

INTERGALACTIC TRAVEL BUREAU

VACATION GUIDE

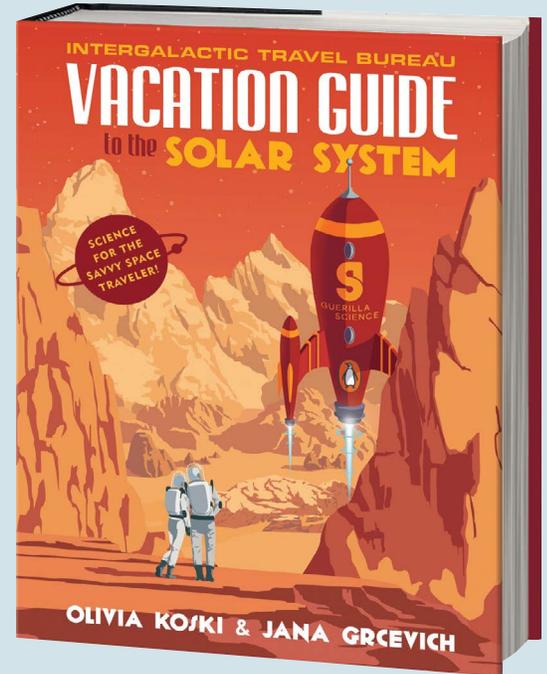
to the **SOLAR SYSTEM**

SCIENCE
FOR THE
SAVVY SPACE
TRAVELER!



Penguin
Random House
ACADEMIC SERVICES

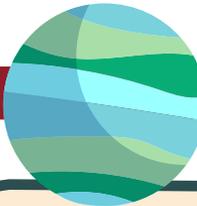
Vacation Guide to the Solar System, by Olivia Koski and astronomer Jana Grcevich, is a whimsical tour of the solar system's most exotic travel destinations. Suitable for courses ranging from Earth Science to Astronomy, science writing, and geology, this book is an exploration of the planets that will inspire students to think differently about their place in the universe—and their next vacation.



DISCUSSION QUESTIONS

Choose a planet. What natural cycles does your planet have, and how would you experience them if you were there?

For example, does your location experience day and night? Seasons? How do they differ from those on Earth?

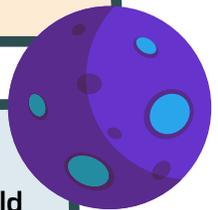


What technical challenges will humans need to overcome before space vacations become a reality? What do you think will be most difficult to overcome and why?



Choose one of the destination chapters from the book (Mercury, Venus, Moon, Mars, Jupiter, Saturn, Uranus, Neptune, Pluto). Would you like to visit this destination or not? Use evidence and explanations from the chapter to support your argument.

If you were to write a chapter on taking a vacation to Earth, what would you highlight? What do you think visitors from other worlds might be interested in seeing? What are some unexpected challenges they might face if they are not native to Earth?



AUTHOR Q & A

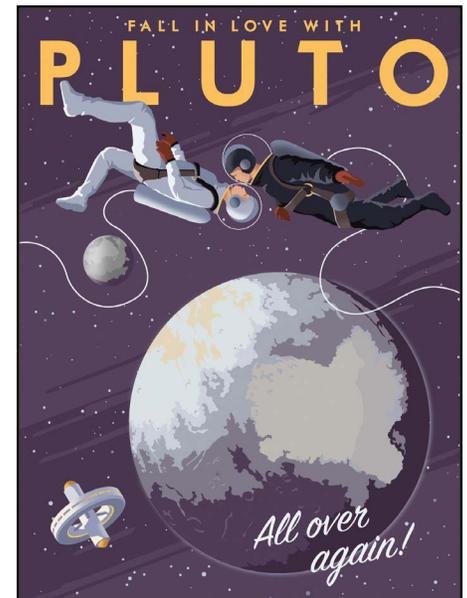
What is the Intergalactic Travel Bureau?

The Intergalactic Travel Bureau is a pop-up travel agency where members of the public can plan their next space vacation. We've brought this fun and educational experience to dozens of festivals, museums, and a storefront on 37th Street in Manhattan. When you visit the Intergalactic Travel Bureau you meet with an intergalactic travel agent, usually a trained astronomer or actor, who gives you a brief summary of different space destinations you can visit. We wrote *Vacation Guide to the Solar System* after planning thousands of these vacations at the Intergalactic Travel Bureau. The idea for the Intergalactic Travel Bureau came from the organization Guerilla Science (guerillascience.org), which connects people with science in fun and unusual ways.



Space travel has become an increasingly hot topic due to recent political and environmental changes on Earth. What can those anxious to embark do right now to prepare for space travel?

There are a variety of companies that provide training or even the promise of a possible trip to outer space (see links in reference section). You might consider learning more about space science, astronomy, and rocket engineering. Nutrition, physiology, psychology, medicine, biology, agriculture and the arts are also important topics to study when preparing for your space vacation. We need doctors, farmers, and artists in space as much as scientists and engineers. To prepare physically, you may consider scuba diving lessons or basic flight lessons. You need to get used to being comfortable in different types of environments. You'll want to be in shape before you go since long-term visits to space can weaken your body. Space tourism is still in its infancy and it's uncertain when the first private tourists will visit the Moon and Mars. Once they do, they will quickly appreciate how good life is on Earth! There is air to breathe and water to drink. It's the only planet that we know of that is habitable for human life.



What was your research process for gathering all of these unique, scientific facts about the planets?

We interviewed dozens of scientists who study planets and moons. We also read a lot of scientific journal articles and books. There is a lot of useful data from NASA (see references) that is publicly available and easy to access. There are varying degrees of information about the different destinations. Places like Uranus and Neptune have less imagery and scientific data to draw from. They haven't been the focus of a really significant scientific mission since the Voyager missions, which were launched in 1977. After learning all we could about each planet, moon, or dwarf planet, we then imagined all the different activities you might try on a vacation to them. It involved calculating the physics of falling and jumping in different gravity environments. That part was the most fun.



What surprised you the most during your research for *Vacation Guide to the Solar System*?

What seems like a basic question: how long does it take to get to Jupiter? Is not as simple as it seems. You have to consider many different facts, such as the position of Earth relative to Jupiter when you depart and when you arrive. What type of rocket technology do you use? What type of fuel do you have, and how much? Do you want to drop into orbit with the planet, or just fly by? Your future vacation destination is a moving target, and Earth is also moving, so it makes the timing of your trip rather complicated. The complexity of planning that part of your trip was surprising.

It's also surprising how much we still don't know about the planets, even though we've discovered a lot. For example, we know that Jupiter's moon Europa has an icy surface, and scientists believe there is a liquid water ocean beneath it. However, no one can give us a straight answer as to how thick that layer of ice is. It might be a few miles, it might be twelve miles thick, or even twenty. It's a debate. So that obviously impacts what your experience will be like on Europa—how much ice you're going to have to dig through to get to that ocean for a submarine tour.



When do you predict some of these planets will be feasibly available for travel bookings?

Ha! The company SpaceX has ambitious plans to ferry people to the Moon ASAP. They're hoping to send people to the Moon and back (without landing) within a few years. So when you hear something like that, it feels quite close. But there is a lot of uncertainty. We've been hearing a lot of promises about suborbital tours for six or seven years. A suborbital trip is a short trip to the edge of space, where you can see the curvature of the Earth. It's not quite as complicated as sending someone to the Moon, but those trips have yet to happen even though hundreds of people have bought tickets (they cost around \$200,000). For around \$50 million, you can take a trip to the International Space Station. As for farther places, it's difficult to say. Within 100 years there should be tourist sites on the Moon and Mars, and possibly even in the skies of Venus.

What's your favorite intergalactic vacation go-to spot?

The skies of Venus. The temperature and pressure 34 miles above the surface of Venus is quite similar to Earth. Saturn's moon Titan is also one of our favorites because you can fly under your own power there because the air is so thick and the gravity is low.



What is the next step for the Intergalactic Travel Bureau to get us into space (figuratively or literally)?

We have a free virtual reality app called Space Vacation (available at guerillascience.org/ith) that will let you "visit" the Moon, Mars, and Europa with your smart phone and an affordable Virtual Reality viewer like Google Cardboard. We're super excited about this as a STEM teaching tool, and just a fun experience for anyone who is curious about visiting the stars.

CLASSROOM ACTIVITIES

1 Imagine you are arriving at one of the following destinations. Write a travel journal entry as if you are approaching your destination. What do you see? How long have you been travelling? Are there places or activities you are most excited to see or do, and why? Use scientific imagery from the Planetary Society and NASA (see references for links) to inform your writing.

- Mercury
- Venus
- Moon
- Mars
- Asteroid in the asteroid belt
- Jupiter
- Io
- Europa
- Saturn
- Titan
- Uranus
- Neptune
- Pluto
- Charon

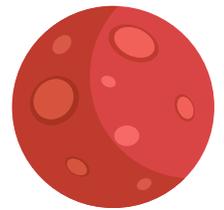
3 The Intergalactic Travel Bureau's venture capital arm is looking to invest \$10 billion for a new space tourism venture. You have 20 minutes to prepare your pitch and 2 minutes to present it. Use the "At a Glance" sections from the book to inform your ideas. Include the following information:

- Company Name
- Tagline (example: "The sky is no limit")
- 2-3 sentence description of your unique offering (example: "bungee jumping on Pluto")
- Why are you different or better than other tourism companies? What problem are you solving?
- What did you take into account while preparing your pitch and why (gravity conditions, temperature, seasons, etc.)?

2 Choose three favorite activities that you enjoy doing on vacation or in everyday life: hiking, surfing, swimming, relaxing, playing video games, biking, skiing, sightseeing, going to the movies, etc. Describe how those would be different at your chosen destination due to differences in the environment, physics, etc. To start, think about how the following might affect your activities:

- Gravity
- Temperature
- Atmosphere
- Landscape
- Geology
- Day Length
- Year Length
- Illumination
- Weather
- Communication Delay with Earth

Example: Video games would be a fun activity on the trip to Mars, especially because you will be spending a long time in a small space en route to your destination. However, it would be difficult or even impossible to play video games in real time with your friends back on Earth, even from a "close" location such as Mars. The round-trip light travel time, which is the fastest any messages can travel, is 3 to 22 minutes. Electronics in space are susceptible to radiation damage, so you would also need to pack "radiation hardened" hardware, which is designed to protect from cosmic ray damage.



4 The table below shows the average length of a year on different planets, defined as the time it takes that object to go around the Sun. Earth's year is 365.2 Earth days long. How many years old are you if you define a year according to your destination's definition?

MERCURY	88.0 Earth days
VENUS	224.7 Earth days
MARS	687.0 Earth days
JUPITER	4,331 Earth days
SATURN	10,747 Earth days
URANUS	30,589 Earth days
NEPTUNE	59,800 Earth days
PLUTO	90,560 Earth days

On which planets have you lived fewer "local years" than Earth years?
 On which planets have you lived more?
 Calculating when your next Mercurian birthday falls on the calendar is not a simple problem.

First, you will need to convert your calendar birthday in Julian days, a measure of time often used by astronomers in which days are simply counted from a starting date of noon on Monday, January 1, 4713 BC. You can use formulas you research on the web to do this, or use the website <https://ssd.jpl.nasa.gov/tc.cgi> to calculate it for you.

Next, find your current age in days. Find the minimum multiple of 88 days which is greater than your age in days. You can then add that multiple of 88 days to the Julian day corresponding to your birthday. This is the Julian day corresponding to your Mercurian birthday.

Finally, convert the Julian day of your Mercurian birthday back to a calendar day. Put the date on your calendar and don't forget to celebrate in a Mercurian fashion.



5 Imagine that our Solar System had formed with a planet called Marupiter in between Mars and Jupiter instead of the asteroid belt. Using the previous questions as a guide, estimate how old you would be if you measured your age in “Marupiter years.”

6 Create a travel poster showing your favorite vacation destination in the Solar System inspired by scientific images from the Planetary Society and NASA (see references for links).

7 Welcome to your first day as an intergalactic travel agent! Pair off and practice planning your first space vacation. Interview your very important “client” to learn about their interests and tastes. Do they like adventure, relaxation, or solitude? What sort of climates do they prefer? The “client” then becomes the “agent” and interviews a different partner. Once everyone has gotten to know their clients better, they’ll write out a “dream” vacation package, tailored to the interests of their partner. Why is this the perfect place for the client? What will they see and do when they arrive at their space vacation destination?

8 You’re a travel writer and you’ve gotten your first big assignment! You’ve been chosen to write about the hottest destinations on the Moon, Mars, and Europa. There’s just one problem—a draft is due tomorrow and you don’t have time to actually go on a trip! Download the Space Vacation app (guerillascience.org/itbvr) to your smartphone, grab a VR Viewer, and go on a virtual space vacation. Then write a one-page guide for aspiring vacationers. Paint a scene for your readers using sensory details to make them feel like they are there.

RESOURCES AND REFERENCES

For references from the book, see <http://guerillascience.org/intergalacticsources/>

Planetary Society Images: <http://www.planetary.org/multimedia/space-images/>

NASA’s Eyes (<https://eyes.jpl.nasa.gov>) is an app for PC, Mac, and mobile devices which renders simulated views of the Solar System and other objects in space

JPL Solar System Simulator (<https://space.jpl.nasa.gov>) allows you to see simulated views of what planets, moons, and other objects look like from various viewpoints within the Solar System with your web browser

To get the free virtual reality space vacation app, which shows realistic landscapes of the Moon, Mars, and Europa in the style of the book, visit <http://guerillascience.org/itbvr/>

INFORMATION ON SCIENTIFIC MISSIONS

The Moon: lunar.gsfc.nasa.gov

Mercury: messenger.jhuapl.edu

Venus: global.jaxa.jp/projects/sat/planet_c

Mars: mars.nasa.gov

Jupiter: missionjuno.swri.edu

Saturn: saturn.jpl.nasa.gov

Pluto: pluto.jhuapl.edu

SPACE TOURISM COMPANIES

SpaceX: <http://www.spacex.com>

Space Adventures: <http://www.spaceadventures.com>

Virgin Galactic: <https://www.virgingalactic.com>

Blue Origin: <https://www.blueorigin.com>

