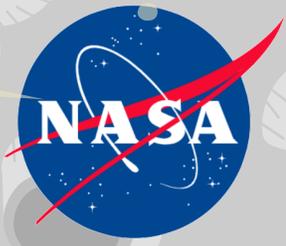


Exoplanets & Alien by Design

Facilitator's Guide



Grantee

Overview

This unit is designed to engage participants with the exciting field of exoplanet research through a series of interactive and creative activities. Participants will explore the methods scientists use to study exoplanets, understand the criteria for habitability, and learn about a newly proposed class of exoplanets called Hycean planets.

The unit will span four main activities: analyzing science fiction aliens, exploring the star K2-18 and its planets with a breakout room, creating 3D models of aliens using Tinkercad, and discussing the ethical and philosophical implications of discovering extraterrestrial life. This unit was designed for middle school aged participants, but could be adapted for younger or older ones as well.

Key Concepts

Exoplanets outside our solar system can either orbit stars or be **rogue planets** not gravitationally bound to a star. Since the first confirmed discovery in the 1990s, 1000s of exoplanets have been identified.

Methods of detection include the transit method (observing dips in a star's apparent brightness as a planet passes in front) and the radial velocity method (detecting wobbles in a star's motion due to gravitational pull from an orbiting planet).

Astrobiology is the study of life in the universe, including the search for habitable environments

For a planet to be considered potentially **habitable**, the best chances are in the "habitable zone" or "Goldilocks zone" of its star, where conditions might be just right for liquid water to exist.

Key factors influencing habitability include the planet's atmosphere, temperature, surface conditions, and the presence of water.

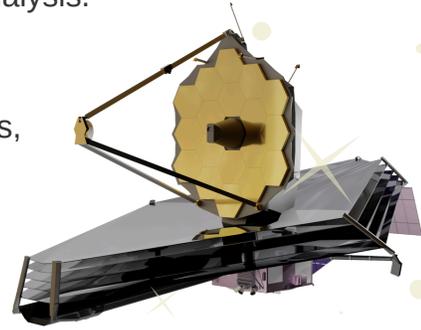
Hycean planets are a new class of exoplanets, proposed by scientists as potentially habitable worlds. The term "Hycean" combines "hydrogen" and "ocean," indicating planets with hydrogen-rich atmospheres and vast oceans. These planets are typically larger than Earth but smaller than Neptune, and they might offer habitable conditions even if they don't resemble Earth.



Discovery and Study of Exoplanets

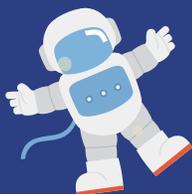
Spacecraft like the Kepler Space Telescope and the James Webb Space Telescope (JWST) have revolutionized our ability to discover and study exoplanets. Kepler's mission has led to the identification of thousands of exoplanets, while JWST's advanced capabilities allow for detailed atmospheric analysis.

Techniques such as spectroscopy enable scientists to determine the atmospheric composition of exoplanets, searching for potential biosignatures like water vapor, methane, and oxygen.



Significance of K2-18b

K2-18b is a sub-Neptune exoplanet partially located in the habitable zone of its star, K2-18. It has become a focus of interest due to observations from JWST which have provided new insights into its atmospheric conditions, reinforcing the possibility of habitability.





Grantee

Scientific Context

Potential for Life on Hycean Planets

The concept of Hycean planets expands the criteria for habitability beyond Earth-like conditions. These planets could harbor life forms adapted to different environmental conditions, such as high-pressure hydrogen atmospheres and deep oceans.

This broadens the scope of the search for life, suggesting that planets we might not have previously considered could be promising candidates.



Teaching Strategies

Interdisciplinary Approach

Integrate astronomy, biology, and language arts to provide participants with a comprehensive understanding of the factors influencing habitability and the potential for life on exoplanets.

Use creative activities, like designing hypothetical alien life forms, to engage participants and encourage them to apply their knowledge in imaginative ways.



Hands-On Learning

Utilize breakout rooms, interactive simulations, and 3D modeling tools like Tinkercad to create engaging, hands-on learning experiences.

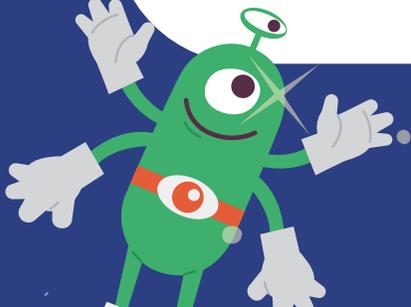
Encourage collaborative projects where participants can work together to solve problems and present their findings.



Critical Thinking

Foster critical thinking by having participants evaluate the evidence for habitability on different exoplanets and discuss the challenges of detecting life beyond Earth.

Promote discussions on the ethical and philosophical implications of discovering extraterrestrial life.





Grantee

Activities



Activity #1: Life on other Planets: Are We Alone?

Purpose:

To examine the features of an extra-terrestrial from a science fiction story and determine what kinds of conditions might exist on its home planet.

Materials Needed:

- Handout for participants

Activity 2: Breakout! Exploring the Star K2-18

Purpose:

 To use a breakout room to:

- Understand the basic properties of the star K2-18: Learn about its type, size, temperature, and location within our galaxy.
- Assess the potential for life on exoplanets orbiting K2-18 and assess the potential for life: Consider the conditions necessary for life and evaluate the habitability of the planets within the K2-18 system.

Materials Needed:

- Handout for participants
- Computer or other device such as a smart phone or tablet to access the internet.





Grantee

Activities

Activity 3: Alien by Design with Tinkercad



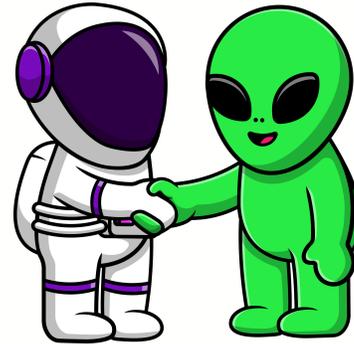
Purpose:

To use the characteristics of the planet in the star K2-18's habitable zone to determine the features of an alien that might live here and to make a 3D model of this alien in Tinkercad.

Materials Needed:

- Handout for participants
- Participants' notes and findings from the breakout room activity
- Paper and pencils for sketching ideas
- Computers with internet access
- Tinkercad accounts
- Optional: MergeEdu accounts, VR headsets or Merge Cubes, tablet or smart phone (for viewing models in virtual reality)

ALTERNATIVE: A stand-alone activity using craft supplies to construct an alien and allowing learners to choose their own exoplanet has been provided at the end of this packet.



Activity 4: Discovering Extraterrestrial Life Wrap-Up

Purpose:

To discuss the ethical and philosophical implications of discovering extraterrestrial life.

Materials Needed:

- Handout for participants
- Paper and pens for reflective writing
- Timer to keep track of discussion segments



Support comes from NASA's Universe of Learning (UoL)

UoL materials are based upon work supported by NASA under award number NNX16AC65A to the Space Telescope Science Institute, working in partnership with Caltech/IPAC, Jet Propulsion Laboratory, Smithsonian Astrophysical Observatory.



Exoplanets & Alien by Design: Activity #1

Life on Other Planets: Are We Alone?

Purpose

To examine the features of an extra-terrestrial from a science fiction story and determine what kinds of conditions might exist on its home planet.

Background

Planets are large objects that orbit a star. In our solar system, the Sun is the star, and there are eight main planets. Each planet has unique features. The inner planets, Mercury, Venus, Earth, and Mars, are rocky and closer to the Sun. The outer planets, Jupiter, Saturn, Uranus, and Neptune, are much larger and made mostly of gases. Together, these planets make up the diverse and fascinating solar system we live in, but they are not the only planets in the universe!

Exoplanets are outside our solar system. Scientists can find exoplanets by observing small changes in a star's brightness or by noticing the star's slight movements caused by the pull of an orbiting planet. By studying exoplanets, we learn more about the many different kinds of planets in the universe and even look for ones that might have conditions where life could exist.

Are we alone? Searching for life on exoplanets is exciting because it opens the possibility of answering this question. Scientists look for exoplanets in the habitable zone, where conditions might be right for liquid water, a crucial ingredient for life as we know it. They use powerful telescopes to detect signs like the right distance from their star, similar to Earth's position relative to the Sun. Scientists also search for specific atmospheric gases, such as oxygen and methane, which on Earth are often produced by living organisms. By identifying these factors, scientists can determine the best potential planets and search for signs of life.



Background

Life on another planet might be very different from life on Earth because it would have to adapt to that planet's unique conditions. For example, if a planet is very hot, the creatures living there might have special ways to stay cool, like thick skin or the ability to live underground. On a cold planet, life forms might have heavy fur or other ways to keep warm. If a planet has a lot of water, more creatures might swim instead of walk. And if the air is different, the way they breathe could be different too. Life on other planets could look and act in ways we can't even imagine, all based on their home planet's environment.

Science fiction stories are great places for imagining what life on another planet might look like through the perspectives of their authors. Including real science in science fiction makes the stories more believable, educational, and exciting. It helps readers understand and appreciate science while exploring what might happen if certain technologies were real.

Science fiction author David Brin has a Ph.D in Physics, a masters in optics and an undergraduate degree in astrophysics. Below is the description of one of his books.

“The first book in the Uplift Trilogy by David Brin, *Brightness Reef* chronicles life on the planet Jijo, where a million years ago the advanced Buyur civilization abandoned the world, leaving it to rest and restore its ecological balance. The vast civilization of the Five Galaxies uses patrols, guardian machines, and sanctions of law to prevent resettlement until the planet is once more deemed ready for civilized life.

But over the centuries it has been resettled. Groups of sapient beings, fleeing persecution or neglect, have ignored the laws, evaded the patrols, and landed in secret. First came the mysterious hoon, then the crablike qheuens, the centaurlike urs, the wheel-borne g'Kek, the multiple-personality-bearing graeki, and last of all to land on Jijo, humans from Earth, bringing with them a new technology allowing civilization to blossom in the wilderness. Abandoning millennia of warfare and mistrust between the six intelligent species, a new society based on tolerance and respect has evolved on forbidden Jijo. They all now live in hiding under canopies of camouflage, in dread of Judgment Day, when the Five Galaxies discover their illegal colony.”

Cast of Aliens

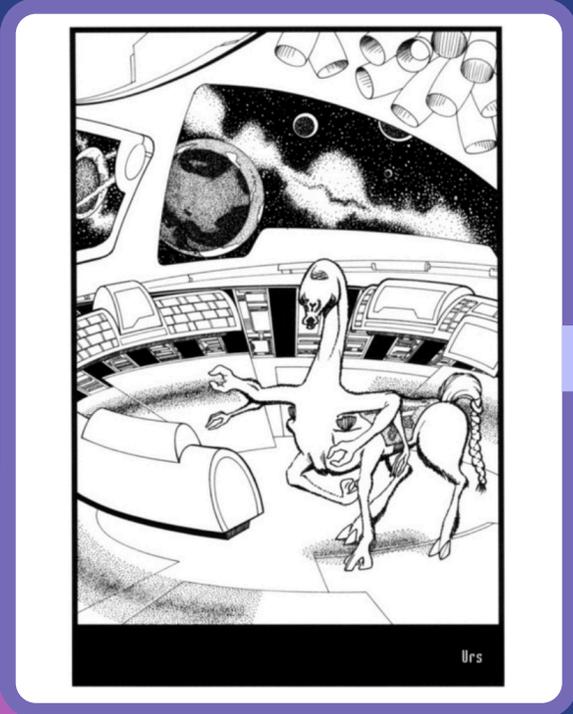


Fig.1 The Urs



Fig.2 The Hoon

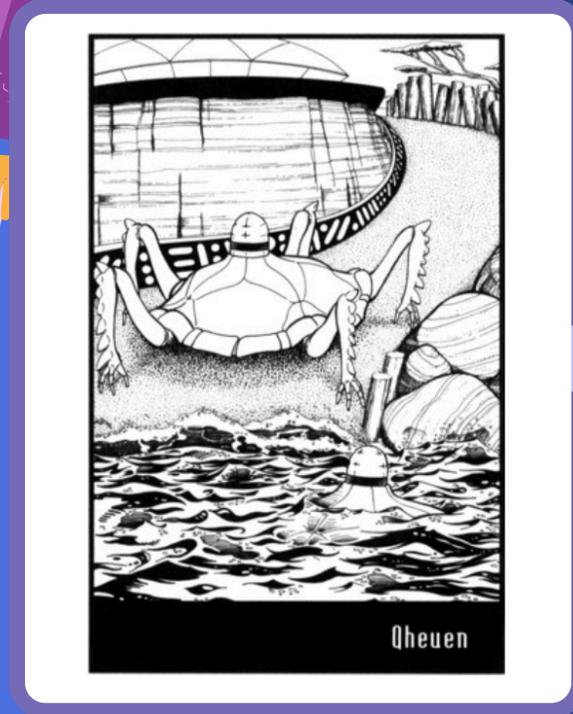


Fig.3 The Qheuen

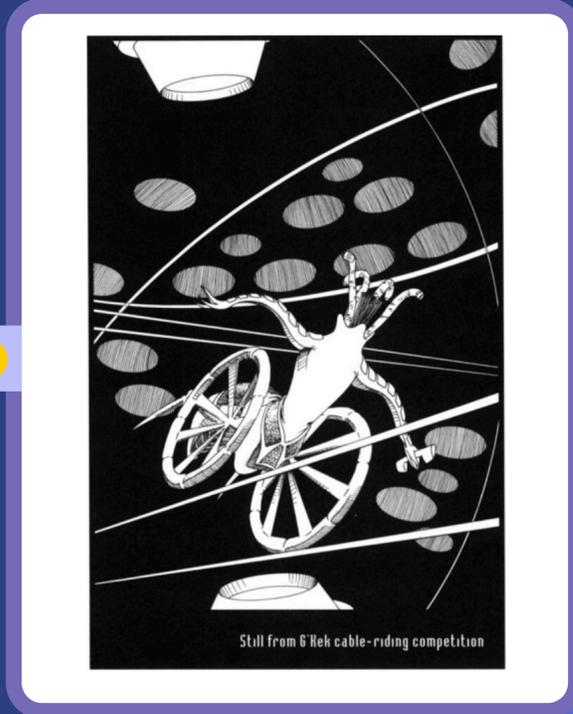


Fig.4 The G'Kek

Task

- 1 Imagine you were given a picture of a creature who migrated to planet Jiro like those in Figures 1-4 on the previous page. Choose one of these creatures, take a close look, and describe the features you see. What do its eyes, skin, or limbs look like? What other features do you see?
- 2 Describe what functions these parts might have. For example, does it have large eyes to see in the dark, tough scales to protect them from predators or sharp rocks, or webbed feet for swimming?
- 3 Based on these features, imagine what kind of environment or planet this alien might live on. Is it a hot desert, a cold ice world, or a watery planet? Be creative and think about how the alien's features help it survive in its unique environment.
- 4 Discuss your results with others. Compare your ideas about the alien's features and its environment. How are your ideas similar or different? What new insights do you gain from hearing others' thoughts?

Works Cited

Brin, David. "DAVID BRIN: Brightness Reef." www.davidbrin.com, www.davidbrin.com/brightnessreef.html.

Brin, David, and Kevin Lenagh. *Contacting Aliens: An Illustrated Guide to David Brin's Uplift Universe*. New York, N.Y., Bantam Books, 2002.

"G'Kek - HTYP." *Htyp.org*, 2024, htyp.org/G%27Kek.



Excerpts

While there are no wrong or right answers to these questions, after the discussion where ideas and thoughts are shared, participants may be interested in the following excerpts from *“Contacting Aliens: An Illustrated Guide to David Brin’s Uplift Universe.”*

“**Urs** are a centaur-like species with four legs and four small arm-like appendages. Two pouches, on each side of the female’s forebody, contain one or two miniature husband-males, but at least one male is expelled when offspring are deposited for brooding. Three eyes form a triangle atop a snout at the end of a very flexible neck. The topmost eye is a lidless composite, sensitive to motion only, its purpose apparently to track the environs even when an Urs sleeps. Urs are obligate carnivores, though they accept cultured or synthetic flesh, if raw. Free water is unusual on the original Urrish homeworld, Urchaka, where most moisture is held in the roots and stems of dense organic mats covering much of the planetary surface. This miracle saved the Mars-like world, but it also meant that animals derived all their water already bound in organic material. As a result, modern Urs are physiologically hydrophobic—they find liquid water unpleasantly caustic. Modern Urs will ingest it only under dire stress. Perhaps this way of life contributes to their short life span, averaging only thirty Earth years.”

“**Hoon** are bipedal, reaching up to 2.5 meters tall, with two elbow joints per arm, and two knee joints per leg. A Hoon’s body is covered in leathery scales, except where the forearms and forelegs bear mats of coarse hair. Their spinal cord is encased in a structure that does not completely grow as they mature. At puberty, a Hoon sheds its youthful spine for a stronger adult replacement, dropping the old one in chunks. A flood of hormones then pushes the Hoon body to maturity in months. Hoon are intensely proud of two physical features—their noses and the resonant voices that first drew attention their way. (Compliments are welcome and flattery can prove effective.) The throat sac on an adult male Hoon, when fully inflated, is over half a meter wide. It emits multilevel chords, sounding like a cross between a foghorn and a cello. But an angry Hoon may screech like an amplified bagpipe. The ‘umble’ is a counterpoint behind most Hoon speech, denoting both mood and underlying meanings. In Galactic terms, the Hoon are listed as ‘low breeders,’ devoting great attention to one offspring at a time.”

Excerpts

“The pragmatic Zhosh, in uplifting these crab-like creatures, left the **Qheuen’s** pre-sapient power structure in place, with gray-carapaced matriarchs dominating the other two classes—blues and reds—in hivesocieties that were far looser than an ant colony, but more rigid than a feudal kingdom. Proto-Qheuen were a warring race, with constant clashes between hives. Today’s uplifted versions have competitive rivalries that seem less violent but more relentless. Ranging from 1.5 to 3 meters in diameter, these armored pentapods have no distinct front or back. Their “head” is a cupola that rises from the center of their body, then drops to protect the ribbon-like eye that wraps around a cylindrical brain-case. The legs are jointed like a lobster’s, with a manipulative claw on each tip. There are five voiceboxes, one between each leg-joint to the main body. Grays are proud of their position atop the race hierarchy and symbolize this by setting up homes on rocky heights. Red Qheuen prefer life in ocean shallows and display an innate curiosity about everything. Blues, by Galactic standards, seem to be the most ‘grounded.’ Their homes tend to be in or near freshwater lakes.”

“A rarity in evolution, the **G’Kek** were a wheeled race. The wheels began as seven thin balloon-like bladders on motile stalks. Evolution—or perhaps genetic intervention by unknown forces—eventually fused the segments into a rigid rim. The hubs, mounted on independent axles, contained fibrous metal organs, which interacted with natural magnets in the torso to create an organic motor. Two hind legs, almost atrophied, provided additional traction by pushing. Young G’Kek were able to run on these legs till their wheel rims fused. G’Kek had a vertical body with an L-shaped balancing tail-stalk. Two tentacled arms with three boneless fingers extended from a shoulderless torso. Adding to the eerie contours of this unusual being were four flexible vision-stalks, each with a single eye, surrounding a central vocal orifice. Anywhere from one to four eyes would focus on a scene, depending on how interesting it seemed.

From *Wikipedia*:

“As a race the **G’Kek** are wheeled creatures with four eye stalks instead of heads protruding from a central cavity, looking rather like ‘a squid in a wheelchair’. Their spokes are susceptible to arthritis in old age, especially under significant gravity. They are known for their talents in weaving and agility and they preferred living in zero-g environments while they were still a part of the starfaring galactic oxygen-breathing civilization.”

Support comes from NASA's Universe of Learning (UoL). UoL materials are based upon work supported by NASA under award number NNX16AC65A to the Space Telescope Science Institute, working in partnership with Caltech/IPAC, Jet Propulsion Laboratory, Smithsonian Astrophysical Observatory.



Grantee

Exoplanets & Alien by Design: Activity #2

Breakout! Exploring the Star K2-18



Grantee

Purpose

To use a breakout room to:

- **Understand the basic properties of the star K2-18:** Learn about its type, size, temperature, and location within our galaxy.
- **Assess the potential for life on exoplanets orbiting K2-18 and assess the potential for life:** Consider the conditions necessary for life and evaluate the habitability of the planets within the K2-18 system.

Background

In 2014, the Kepler Space Telescope, a special tool made to find planets around other stars, discovered a star called K2-18. Kepler, which was launched into space by NASA in 2009, used a clever method to find these planets.

Kepler watched for tiny dips in the light of stars. Imagine a star is like a big flashlight shining towards us. When a planet passes in front of the star, it makes the star's light dim just a little bit. By spotting these tiny changes in the light, Kepler could tell when a planet was in front of a star.

In 2021, NASA launched the James Webb Space Telescope (JWST). With its super advanced technology, JWST can see farther into space and with more detail than ever before, making it perfect for studying planets around other stars.

JWST has been looking at a planet orbiting the star K2-18, and has found some really cool stuff! Using its powerful infrared sensors, JWST can study the light that passes through the planet's atmosphere when it moves in front of its star. This method, called spectroscopy, helps scientists figure out what different gases are in the planet's atmosphere.

This breakout room will help you learn more about K2-18 and its planets.

Task

1 Go to the breakout room at <https://sites.google.com/lewistonpublicschools.org/k2-18breakoutroom/home>.

2 Working with your group, click on parts of the image at the top. These will lead you to challenges or puzzles that your group needs to solve together. These will give you clues to “break” the locks in each chapter of the **Data Log** below the picture. See examples of Lock type below.

DIGITAL BREAKOUT ROOM LOCK TYPES

NUMBER

A specific sequence of numbers such as the 4 Number Lock, 1234. You may need to solve a math problem or puzzle.

LETTER

A specific sequence of letters, such as the 6 Letter Lock, PLANET that comes from a question, word puzzle, secret message, etc.

COMBO

A combination of numbers, letters and symbols such as * or \$ like the 6 Number Symbol Combo Lock, \$14.72.

COLOR

A sequence of colors. For example if you had to put colored objects in a correct order of red, blue, green and yellow, this would yield a 4 Color Lock, RBGY.

DIRECTIONAL

A sequence of directions, like north (N), south (S), east (E), and west (W) or Up (U), Down (D), Left (L) and Right (R). For example a 5 Directional Lock, NWSEN, might be the directions of the path you follow along a map to get from one place to another or to get out of a maze.

3 Enter your data into the **Data Log** and click **Next** to check it. Correct it if necessary to move on to the next chapter until you “breakout!”

4 Now that you've completed the breakout room activity and learned about the star K2-18 and its habitable zone, it's time to dive deeper. Together with the other groups, discuss what you discovered about the planet in K2-18's habitable zone focusing on its atmosphere, potential for water, climate, and any other relevant features. Consider how these characteristics might influence the types of life forms that could exist there. Think about what adaptations or traits these hypothetical aliens might need to survive. Take notes on this discussion to help guide you in the next activity, where you'll bring your alien designs to life using Tinkercad.

Exoplanets & Alien by Design: Activity #3

Alien Models with Tinkercad

Purpose

To use the characteristics of the planet in the star K2-18's habitable zone to determine the features of an alien that might live here and to make a 3D model of this alien in Tinkercad. Have fun and let your imagination and scientific knowledge guide you!

Materials

- Your notes and findings from the breakout room activity
- Paper and pencils for sketching ideas
- Computer with internet access and Tinkercad Account
- Optional: MergeEdu accounts, VR headsets or Merge Cubes, tablet or smart phone (for viewing models in virtual reality)

Task

1

Review the Characteristics of the planet in K2-18's habitable zone:

- Discuss with your group its key features, such as its atmosphere, presence of water, temperature, and climate.
- Think about how these conditions might affect the types of life that could exist there.

2

Brainstorm Alien Features:

- Brainstorm what kind of alien could survive on this planet. Consider:
 - What would it look like?
 - How would it breathe?
 - How would it move?
 - What would it eat?
- Sketch your ideas on paper to visualize your alien's design.

Task

3

Create a 3D Model in Tinkercad:

- Go through the activity, “A Dozen Simple Steps to Get You Started in 3D Modeling with Tinkercad,” at the end of this handout to get practice using Tinkercad.
- Use the tools in Tinkercad to create a 3D model of your alien. Be creative and have fun, but also make sure the features of your alien fit the environment of the planet.

4

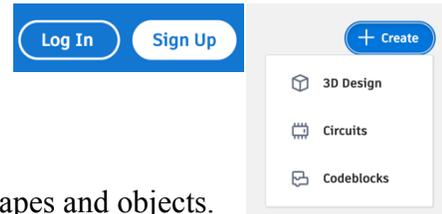
Showcase Your Alien:

- Once you’ve completed your 3D model, be prepared to share it with the class.
- Explain why you designed your alien the way you did, highlighting how it is adapted to live on this planet.
- Optional: view the aliens in virtual reality! Read “**Tinkercad and Merge Cubes**” at the end of this document.



A Dozen Simple Steps to Get You Started in 3D Modeling with Tinkercad

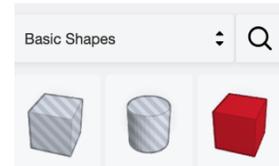
1. Go to <https://www.tinkercad.com/> and **Sign Up** if you are new or **Log In** if you have an account.



2. Click **Create>3D Design**.

3. On the right, you can choose from many premade shapes and objects.

Basic Shapes is the default menu, but there are many others in the drop down menu. You can also use the magnifying glass to search for a particular shape or item. For now, left click and drag the red **Box** to the **Workplane**.

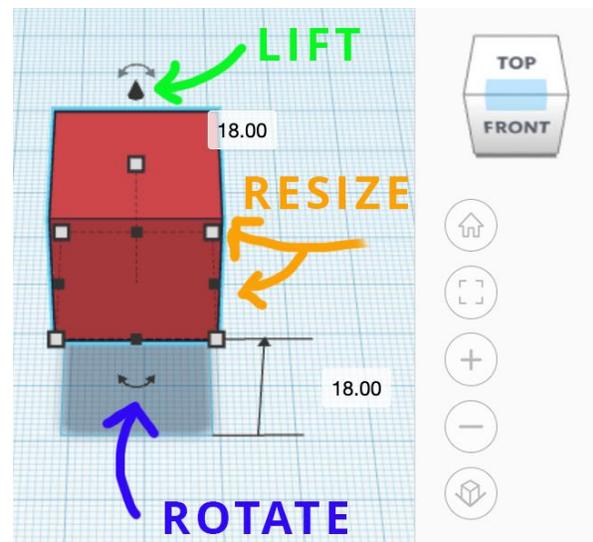


4. The **View Cube** in the upper left corner allows you to look at your box from different angles. Try clicking on different parts of this to see what it does!

5. Use the + and = under the **View Cube** to zoom in and out.

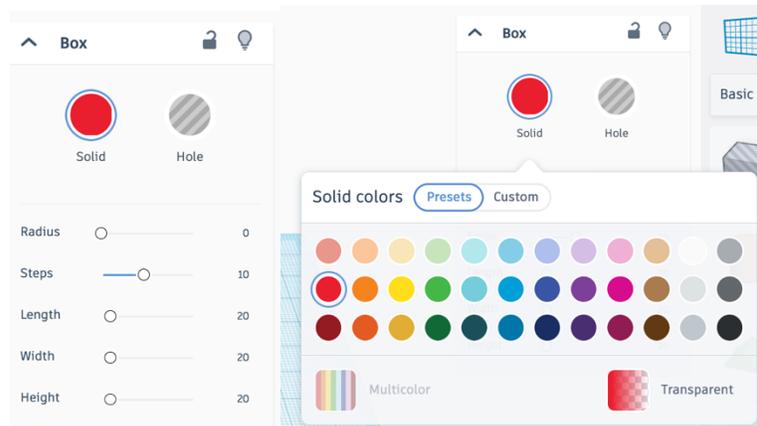
6. To move your box to a different place, left click and drag it.

7. If you click on the box, you will see handles that let you lift, resize and rotate your box as shown to the right. Experiment with these!

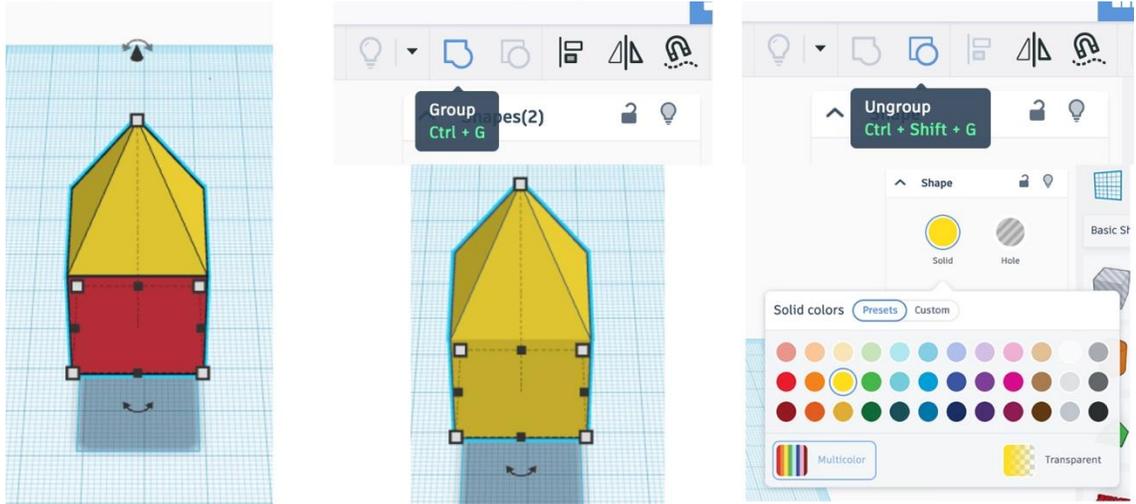


8. You can also resize the box using the **Length**, **Width** and **Height** sliders in the menu shown at the right which will show if the box is selected.

9. Click on **Solid** to change the color from the menu.



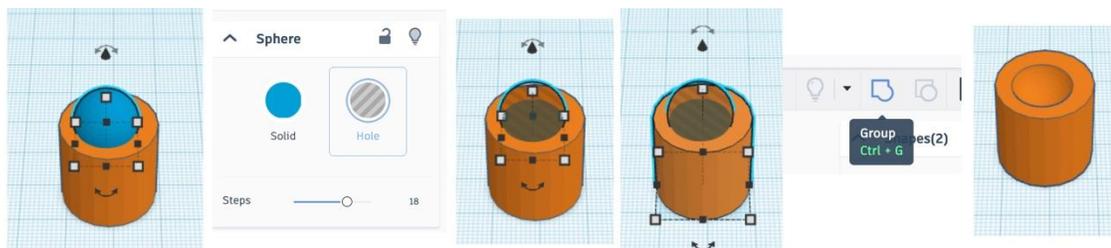
10. Now drag a yellow **Pyramid** from the **Basic Shapes** menu and place it on top of the red **Box**. Hold your **Shift** button down and click both shapes to select them. Towards the upper right corner, find the **Group** icon and click it. This combines the two shapes into one piece. Notice that it changes both to the same color. If you would like them to stay the original colors, click **Solid** and then choose **Multicolor**. If you need to separate your shapes, click on it and then click the **Ungroup** icon.



11. To get rid of something, click on it and then click the **Trash Can** in the upper left corner. If you make a mistake, you can hit the **Left Arrow** to undo your steps and the **Right Arrow** to redo your steps. Delete the object you have made.

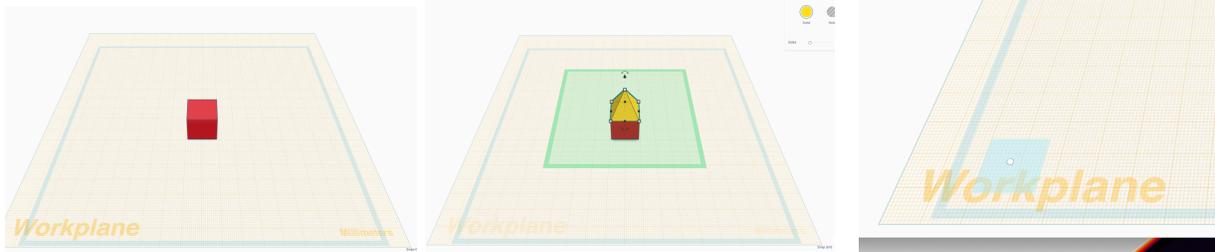
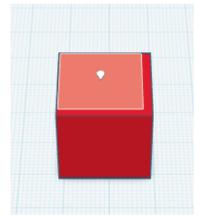


12. Drag an orange **Cylinder** and a blue **Sphere** to the **Workplane**. Make the blue **Sphere** smaller (see steps 7 and 8). Try holding your **Shift** button down as you drag a white or black square and see what happens. Move the **Sphere** over the **Cylinder** and lower it inside as show on the left below. With the **Sphere** selected (click on it), click **Hole**. Notice it turns transparent. Hold your **Shift** key down and select both the **Cylinder** and the **Sphere** by clicking on them and then **Group**. Look what happens! This is a good way to make your own new shapes!



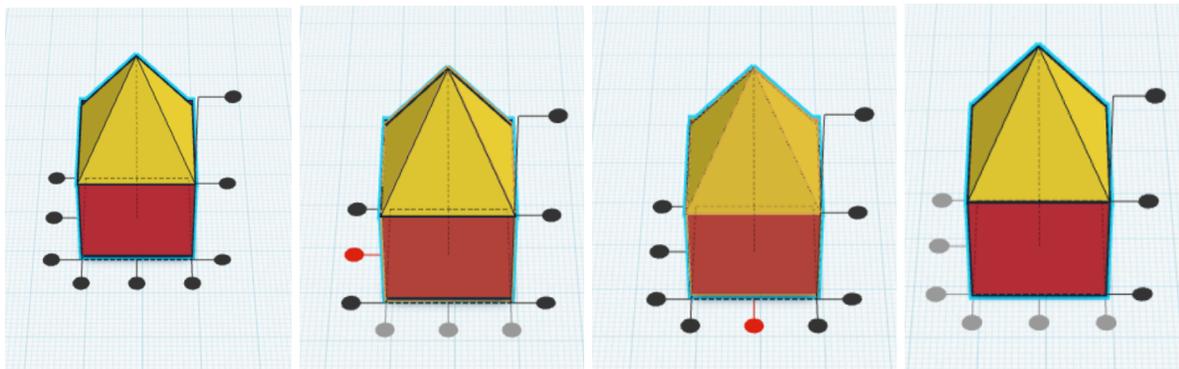
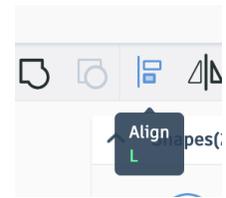
MORE TINKERCAD: Align Objects

In step #10, these things can also help you place the pyramid in the desired spot. Press **W** on your keyboard. Move your cursor to the top of the cube and click. This places your **Workplane** on top of the cube. Now when you drag over your yellow pyramid, it will place it on top of the red cube at the correct height.



Type **W** again and click on the original **Workplane** to return it to its former position.

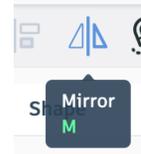
Holding your shift key down, click both the cube and the pyramid so they are both selected. To align the pyramid so it is centered over the cube, type **L** or click the **Align** icon. Dots will appear. Clicking on the dots shown in red below will center the pyramid on the cube. Dots turn gray when the shapes are aligned in those directions.



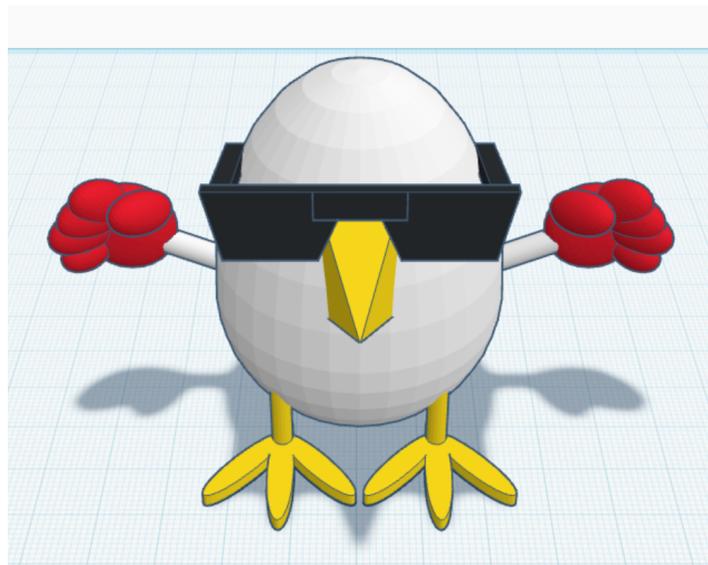
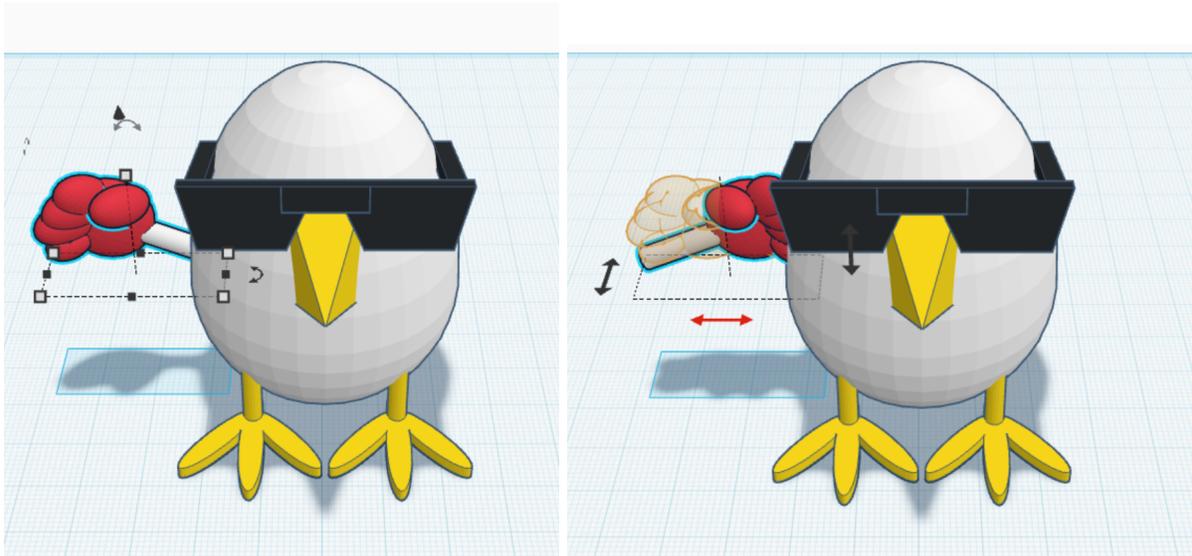
MORE TINKERCAD: Duplicate and Mirror Objects

Do you need more than one of something you've made? Click on it to select and press **D** to **Duplicate** it with its properties. Move it to where you want it.

Need a mirror image of an object? Click on it to select and press **M** or click the **Mirror** icon. Click on the desired arrow to mirror it in that direction.



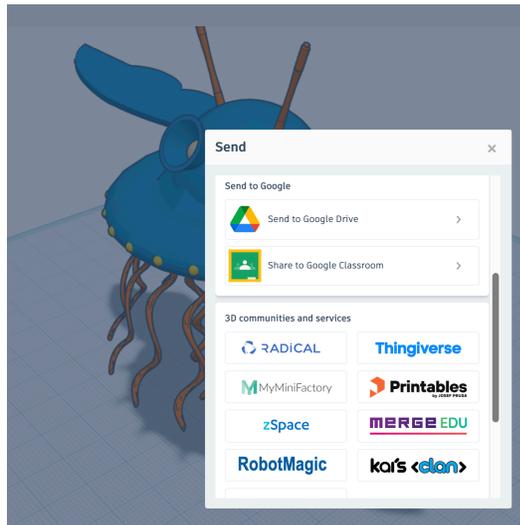
Below I selected the arm, hit **D** to duplicate it, then **M** and the arrow shown in red to mirror it. I then moved the new arm into place.



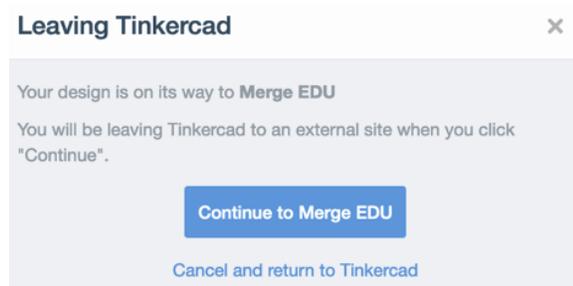
Tinkercad and Merge Cubes

If you have a **MergeEDU** account, this is one cool way to view your alien creation in virtual reality! Follow the steps below to send your alien from **Tinkercad** to **MergeEDU**.

1. Go to <https://www.tinkercad.com/>. Tap the “**Sign In**” button to sign into your **Tinkercad** account.
2. Go to dashboard.mergeedu.com in a new tab and sign into your **MergeEDU** account. This will ensure that when you send your object to Merge, it goes to your account.
3. Go back to your Tinkercad tab. Hover over the 3D Object you want to export and click **Tinker this** to open the object.
4. Click **Send to** in the upper right corner and choose **MERGEEDU** from the menu that come up.



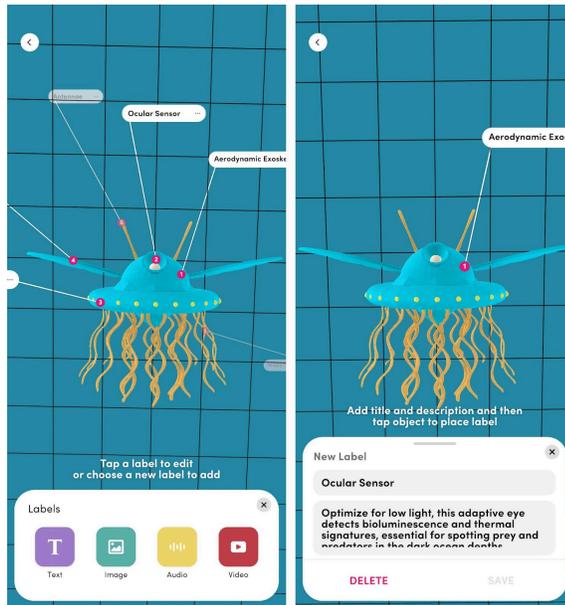
5. After the object loads, click **Continue to MergeEDU**.



6. **Add information** (text, images, audio and/or video labels) to your object! On your tablet or smartphone search for and install the **Merge Creator** app (in Google Play or on the Apple App store).



7. Open **Merge Creator** and tap on the object you wish to edit. Click **Labels** and the type of label you want to add. For **Text** labels, enter the name and then a description, tap where it is on your object and then click **Save**. Continue with as many labels as you like!



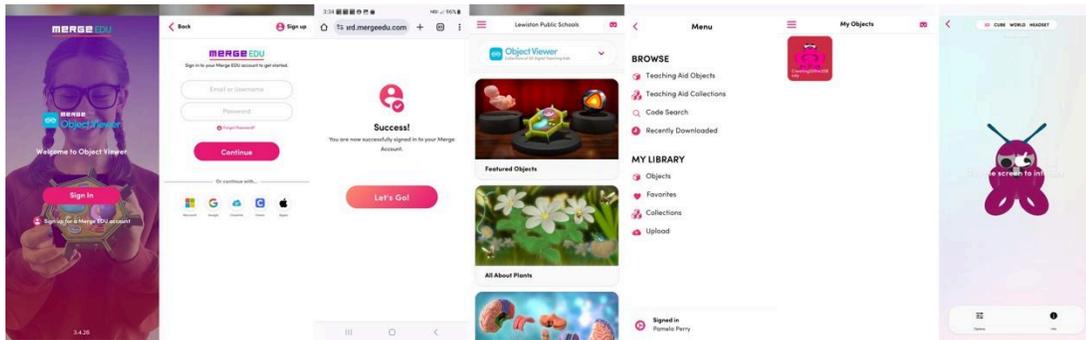
8. On your tablet or smartphone search for and install the **Object Viewer** app (in Google Play or on the Apple App store).



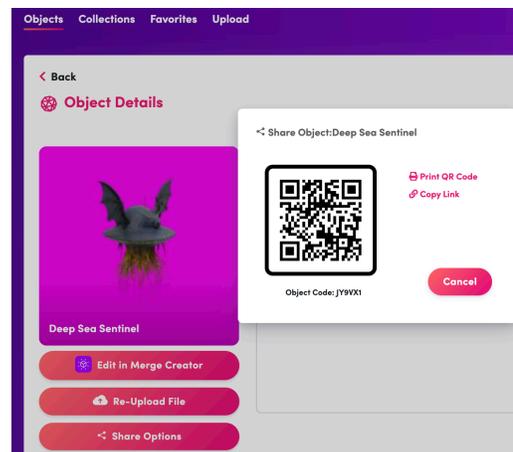
9. Open **Object Viewer** and click **Sign In** and sign in to your MergeEdu account.
10. On the **Success!** screen, click **Let's Go**.
11. In the upper left corner of the next screen click the  to get the menu.
12. On the next screen, choose **Objects** under **MY LIBRARY** and then tap the object you wish to view.

13. You have 4 different ways to see your object in virtual reality.

- 3D** – touch your screen and move your finger to see your object from different angles.
- Cube** – this requires a Merge Cube. You can buy one or make a paper one following the directions here:
<https://support.mergeedu.com/hc/en-us/articles/360052933492-Making-a-Merge-Paper-Cube>
- World** – hold your smart phone or tablet over the surface where you want to place your object. After you scan the surface, you will be prompted to tap to place your object. You then can move your device around to view the object.
- Headset** – For this you need a smart phone and a VR headset. VR. Read the warning and then scroll to the bottom and click **Continue**. Rotate your smart phone so that it is sideways and put it into the headset. An inexpensive headset is Google Cardboard. <https://arvr.google.com/cardboard/>. Move your head around and enjoy!



14. Do you want to share your creations with others? Go back to your dashboard online at **Merge EDU** and click **My Stuff** and then click on the thumbnail of the object you wish to share and then **Share Options** on the next screen. You will have the option to **Print QR Code** or **Copy Link**. Using this with their device, they will go straight to **ObjectViewer** and be able to view your object as above!



Exoplanets & Alien by Design: Activity #4

Discovering Extraterrestrial Life Wrap-up

Purpose

To discuss the ethical and philosophical implications of discovering extraterrestrial life.

This wrap-up activity will help you think deeply about the bigger picture and the impact that discovering extraterrestrial life could have on humanity. It's a chance to use your imagination and consider the future of space exploration and our place in the universe.

Task

Group Discussion:

- Divide into small groups.
- Each group will be assigned one of following questions to discuss:
 - What would be the impact on our society if we discovered extraterrestrial life?
 - How should we communicate with potential alien civilizations?
 - What are the ethical considerations of exploring and possibly interacting with alien life forms?
 - How might discovering extraterrestrial life change our understanding of our place in the universe?

Group Presentation:

- After your discussion, each small group will present their thoughts and ideas to the whole group.
- Share the key points and any interesting arguments or perspectives that came up during your discussion.

Task



Class Debate:

- As a whole group, we will have a debate on one of the questions, such as "Should we attempt to contact extraterrestrial civilizations if we discover them?"
- Take turns presenting your arguments and listen respectfully to opposing viewpoints.



Reflective Writing

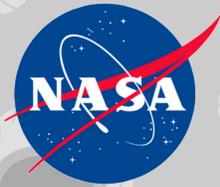
- Individually, write a short reflection on what you learned from the discussions and debate.
- Consider how your own views might have changed or been influenced by the activity.



Wrap-Up:

- We'll end with a whole group discussion summarizing our thoughts and reflecting on the entire unit.
- Share any final thoughts or questions you have about the search for life on exoplanets.





Grantee

Exoplanets & Alien by Design: Alternative Crafty Extra Terrestrials

Purpose

To design and create an alien life form using craft supplies, based on the unique conditions of a distant exoplanet

Materials

To create your alien, you can use a variety of craft supplies. Below is a list of suggested materials, but feel free to be creative and use anything you have on hand!

- Craft Paper (colored and plain)
- Markers, Colored Pencils, or Crayons
- Modeling Clay (various colors)
- Pipe Cleaners (for arms, legs, antennas, etc.)
- Googly Eyes (optional for eyes and other features)
- Glue or Glue Sticks
- Scissors
- Construction Paper (for background or larger features)
- Foam Sheets (for texture or body parts)
- Cotton Balls, Pom-Poms (for soft textures or body parts)
- Aluminum Foil (for metallic surfaces or protection layers)
- Feathers, Felt, or Fabric Scraps (for fur, wings, etc.)
- String or Yarn (for hair, tentacles, or other features)
- Beads or Buttons (for eyes, joints, or decorations)
- Tape
- Pencils and Erasers (for sketching out your design)
- Planetary Fact Sheet (printed from the website, or notes from the research phase)



Task

1

Explore the Exoplanets

Go to <https://science.nasa.gov/exoplanets/immersive/strange-new-worlds/> and pick one exoplanet to focus on. Pay close attention to details like:

- Temperature (Is it freezing cold or blazing hot?)
- Atmosphere (Does it have air like Earth's or something different?)
- Gravity (Is it heavier or lighter than Earth's?)
- Water or other liquids (Is there any water, or does it have something else?)
- Surface conditions (Rocky, icy, covered in gas, etc.)

2

Imagine Life on Your Exoplanet:

Think about what life would need to survive on your chosen planet. Consider:

- Body Shape: Would the alien need to be big and strong, or light and small?
- Senses: What senses (sight, hearing, smell) would be important for survival?
- Movement: How would your alien move around—crawl, fly, swim, or something else?
- Protection: How would it protect itself from extreme temperatures or dangerous conditions?

3

Sketch Your Alien:

- Before jumping into the craft supplies, sketch out your alien on paper. Make sure it fits the conditions of the planet you chose. Include any special adaptations that help it survive.

4

Craft Your Alien:

- Using the craft supplies provided (clay, paper, pipe cleaners, etc.), build your alien based on the sketch. Use your creativity to make it unique and reflective of the planet's environment!

5

Explain Your Alien's Adaptations:

Write a short description of your alien. Explain why it looks the way it does and how its features help it survive on the exoplanet you picked. Answer these questions:

- How does your alien breathe, move, and find food?
- How does it protect itself from the planet's conditions?
- What makes it perfectly suited to life on this exoplanet?

Thank you to **Julie E. Czerneda** for her contributions to this activity. Julie is a Canadian science fiction and fantasy author known for blending her background in biology with imaginative storytelling. Visit her here: <https://czerneda.com/>