



## Scale of the Galaxy & Universe

**Prep Time:** 30 minutes

**Grades:** 5-8

**Lesson Time:** 60 minutes

### Essential Questions:

- How far away are the closest stars?
- Where is the habitable zone for planets?
- What would be necessary for potential life on other planets?

### Objectives:

- Students will be able to understand the scale of the galaxy.
- Students will be able to determine what is necessary for life on a different planet by making observations of our solar system and their lives.

### Standards:

- MS-ESS1-3 Analyze and interpret data to determine scale properties of objects in the solar system.
- 5-ESS1-1 Support an argument that differences in the apparent brightness of the Sun compared to other stars is due to their relative distances from the Earth.
- Anchor Standard #3. Refine and complete artistic work.
- Anchor Standard #4. Select, analyze and interpret artistic work for presentation.
- Anchor Standard #5. Develop and refine artistic techniques and work for presentation.
- Anchor Standard #6. Convey meaning through the presentation of artistic work.

### Teacher Prep:

- The play script attached to the document is meant to be performed in front of an audience. Scripts and roles should be assigned ahead of time to prepare for the presentation.
- Plenty of opportunities exist for students who would prefer not to be on stage. Students can assist in costume design, set design, lighting, and nonspeaking extra roles on stage.

### Teacher Notes/Background:

- This script is flexible in that it can be performed with little access to props and costumes or it can be done extravagantly based on how much time is available for this lesson.
- Large speaking roles: Ryan, Camilla, & S.T.A.N. (Space Travel Automated Networker). S.T.A.N.'s role is all off stage, the character never actually appears on stage.
- Medium speaking role: Commander Jay Scott.
- Small speaking role: Technician #1 & #2.
- Non-speaking role: Mercury, Saturn, and any other extra technicians you choose to include in the laboratory scenes.
- There are points in the script where the actors break the scene to audience for help answering the questions, so make sure your class is prepared and knowledgeable, so they can participate in these moments.

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<b>Engage</b> (1-2 minutes)	<p><b>Acting Exercise:</b></p> <ul style="list-style-type: none"> <li>• Have students warm up their facial expressions and bodies with a quick short exercise called “The Gardener.”</li> <li>• Direct students to stand up and reach as high and they can and pretend like they are picking apples, then reach down low and pretend like they are pulling weeds.</li> <li>• After that have them come back to a standing position. Tell students you see a deer munching on the vegetables you have been growing and they are angry at the deer. Have them make a big, angry expression.</li> <li>• Then, tell students they just picked the biggest pumpkin they have ever grown, and they are extremely excited! Have them make an extremely excited expression.</li> <li>• Next, tell students that they planted some tomato seeds, but they never sprouted, and they’re confused. Have them make a confused expression.</li> <li>• Wrap up the activity and have students take their seats.</li> </ul>	<p><b>Materials:</b> N/A</p>
<b>Explore</b> (10 minutes)	<p><b>Attached Worksheet:</b></p> <ul style="list-style-type: none"> <li>• Distribute the attached worksheet. Students can work on this individually or in pairs. The information on the worksheet is key information that is described throughout the play.</li> <li>• By having students fill this out, it ensures that those who do not necessarily want a main role are still reviewing the information.</li> <li>• The correct order for closest to farthest is Mercury, the Sun, Saturn, Alpha Centauri.</li> </ul>	<p><b>Materials:</b></p> <ul style="list-style-type: none"> <li>• Attached worksheet</li> </ul>
<b>Explain</b> (40 minutes)	<p><b>Perform Play:</b></p> <ul style="list-style-type: none"> <li>• This section has some flexibility. If you have time, you can design props, sets, and costumes. It is also possible to simply print out scripts and do a dry run in front of the classroom on the same day.</li> <li>• The play is divided into different scenes. Assign each group a different scene. Since there are not many speaking roles, if you have a larger class, you can assign different students to different roles within the group. One can do set and prop design, one can do costume design, and one can do the physical acting.</li> <li>• If you have time to dive deeper into this activity, set, costume, and prop suggestions are included in the play script. Students who are not as likely to volunteer for a speaking role can play a major part in the design aspect of the production.</li> </ul>	<p><b>Materials:</b></p> <ul style="list-style-type: none"> <li>• Play scripts</li> <li>• Any costumes, props, or set designs available</li> </ul>

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<b>Elaborate</b> (5 minutes)	<b>Director's Notes:</b> <ul style="list-style-type: none"><li>• Students should write down what they thought the actors/actresses did well in the performance.</li><li>• Students should also note what they thought was most important about putting on a play. How could they make it better? (Vocal projection? Costumes? Sets? Props?)</li></ul>	<b>Materials:</b> <ul style="list-style-type: none"><li>• Attached worksheet</li></ul>
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<b>Evaluate</b> (5 minutes)	<b>Wrap-up Questions:</b> <ul style="list-style-type: none"><li>• What is the Goldilocks (habitable) zone?</li><li>• What is essential for life?</li><li>• What kinds of people and professions are necessary to explore the universe?</li></ul>	<b>Materials:</b> N/A
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### Extensions and Enrichment:

- If possible, film the play and put distribute it to students in your class.
- Perform this in front of the school at an assembly. Field questions from the audience.

### Additional Resources:

- See attached worksheets

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You and your classmates will work on performing a play about the “Goldilocks Zone” or the habitable zone for planets that could potentially have life. Complete the exercises below to get you thinking about some of the key elements that will be incorporated into this play.

1. In the circle, list what you think living things need to survive.



2. What major elements make up Earth’s atmosphere?

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3. Define the Goldilocks (or habitable) zone.

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4. Put the following destinations in order from closest to farthest away from Earth.

**Destinations:**

- Mercury
- Saturn
- Alpha Centauri
- The Sun

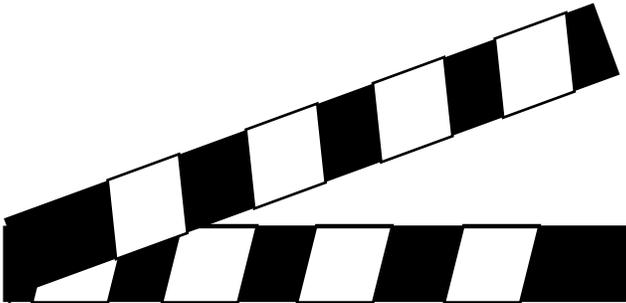
**Order from Closest to Farthest:**

1. \_\_\_\_\_
2. \_\_\_\_\_
3. \_\_\_\_\_
4. \_\_\_\_\_

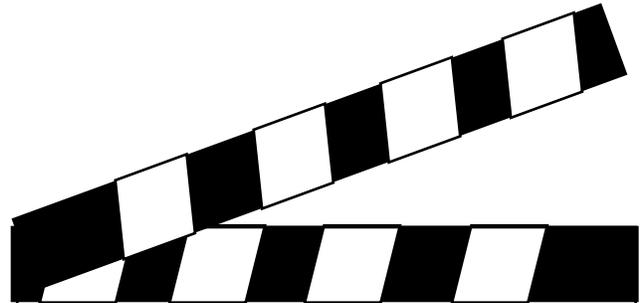
# Scale of the Galaxy & Universe

## Director's Notes

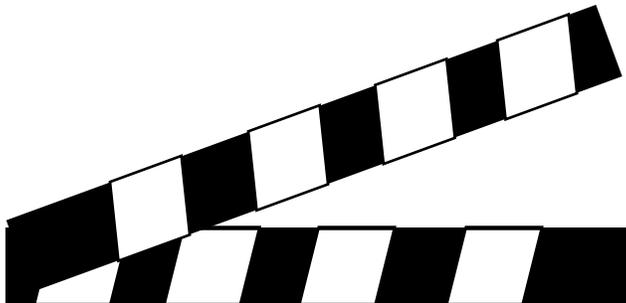
Putting on a play involves more than just the actors! Sets need to be designed, makeup applied, costumes and props made, lighting and sound adjusted, and of course, it needs to be directed! It takes so many people to put on a successful production. Take some time to add notes below about the play you and your classmates just put on, so you can be even more successful in the future!



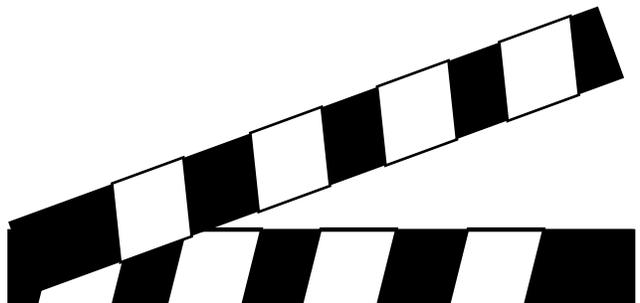
**What was most important in the play?**



**How did I help produce the play?**



**How could we make the play better?**



**What could my role be in future plays?**

# Scale of the Galaxy & Universe

The Habitable Exoplanet

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# Scale of the Galaxy & Universe

## Character List:

**Commander Jay Scott**

**STAN (Space Travel Automated Networker)**- to be read off stage in a robotic voice

**Astronaut #1 (Ryan)**

**Astronaut #2 (Camilla)**

**Mercury** – composed of 3 students who will hold hands/wear the same color t-shirt to represent Mercury, unspoken role

**Saturn** – composed of 3 students who will hold hands/wear the same color t-shirt to represent Saturn, unspoken role

**Technician #1**

**Technician #2**

## Costumes:

Students who play the planets and stars (Mercury & Saturn) should wear matching shirts and cards with the name of the planet around their neck large enough for the audience to see.

Characters dressed as Saturn need to have some sort of rings around their entire formation to highlight one of Saturn's most distinctive qualities.

Ryan and Camilla should be dressed as astronauts.

Commander Jay Scott should be dressed in white lab coat or other type of laboratory attire.

Lab technicians should also be dressed in laboratory attire.

## Props:

Desks for laboratory

Laptops/electronic props

Any type of lab equipment (notebooks, beakers, etc.)

## **NOTE:**

There are highlighted portions of the script where you need to fill in information with your own ideas and lines! Be on the lookout for these special sections.

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### Scene One (Same group as Scene Five):

*[Design a set that looks like a laboratory. What technological aspects would you include? What kind of technology do you think the astronauts will need? Use your knowledge of outer space, the Sun, and stars to design this set!]*

*(Enter in Commander Jay Scott)*

**Commander Jay Scott:** *(sternly)* Good morning astronauts. I am your Commander, Jay Scott. I know you have already been briefed with your mission: you must find a habitable area where humans could potentially live. As you know our planet is under severe threat of losing its ability to support life. Remember, you have your Space Travel Automated Networker, or STAN for short, who we have programmed with information to help you along your journey. We have programmed STAN with as much information as possible, but unfortunately, we don't know every single question you will have along your journey. You may have to ask your friends back home for some help at some point if STAN doesn't know the answer. I wish you the best of luck on your journey. Are you all ready to take off?

**Ryan:** Ready!

**Camilla:** Ready!

**Commander Jay Scott:** Alright, good luck astronauts!

*(Exit Commander Jay Scott)*

*(Ryan and Camilla walk over to space shuttle chairs, sit down, and prepare for their launch)*

*(Lights turn off)*

*(Ryan and Camilla remain seated, close eyes, and prepare to "launch" to outer space")*

**STAN:** *(From offstage)* Ryan and Camilla, this is STAN, welcome! You have been chosen for a space exploration into our solar system, and, if needed, maybe even beyond that. Your shuttle will be lifting off in 10, 9, 8, 7, 6, 5, 4, 3, 2, 1...we have liftoff!

*(Ryan and Camilla stand up and desks and chairs should be removed from the stage)*

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## Scene Two:

*[Ryan and Camilla are now in space. The scene should have some sort of starry background. Mercury actors should be standing on stage. In order to represent that they are the planet, they should be wearing the same color shirt, with some sort of sign on them that says Mercury and holding hands in a circle. Their backs should face each other so that instead of facing inward holding hands in a circle, they are turned outward so that the audience will be able to see their faces. The students can occasionally rotate so each of their faces will face the audience.]*

**Ryan:** Wow! I can't believe we're in outer space!

**Camilla:** I know! It's so amazing! Now, we need to figure out what is necessary for life as we know it. Ryan, what are some things we need to live on Earth?

**Ryan:** Well, I know humans need **[what do humans need to survive? Write that into the script!]**

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**Camilla:** Well, eventually we'll need **[add your own ideas about what is necessary for life here!]**

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too, but let's start with the first one, water. Do you think Mercury would have any water on it?

**Ryan:** I'm not sure, let's go there and check it out!

*(Ryan and Camilla walk over towards Mercury)*

**Camilla:** Wow! Mercury was really far away! STAN, how far did we have to travel from Earth to Mercury?

**STAN:** Computing.....you traveled **[how many miles away is Mercury from Earth?]** \_\_\_\_\_ miles to get to Mercury.

**Ryan:** Geez! At least traffic was light!

**STAN:** The speed of light is 186,000 miles per second.

**Ryan:** It was a joke, STAN.

**STAN:** Oh, your sense of humor must be above my technological capabilities.

**Ryan:** *(laughing, nudging Camilla)* Gee, thanks STAN!

**Camilla:** *(sarcastically)* Oh great, this is going to be a LONG trip. Anyways, let's get back to this, what do we know about Mercury, STAN?

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**STAN:** Mercury is the [smallest or largest?] \_\_\_\_\_ planet in our solar system and the planet [closest or furthest?] \_\_\_\_\_ to the Sun. Mercury is barely larger than Earth's moon.

**Ryan:** Thanks STAN, we need to know if Mercury can hold liquid water, what can you tell us about that?

**STAN:** Temperatures range from -290 degrees Fahrenheit to 800 degrees Fahrenheit, so no, there is no sign of liquid water on Mercury.

**Camilla:** Thanks STAN, alright so no liquid water on Mercury, looks like we're going to have to do a little more looking.

*(ALL exit stage)*

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### Scene Three:

*[A different space scene should be set up if possible. Ryan and Camilla are still in space at this point. Saturn actors start on stage in the same setup as Mercury, just standing in a different position to represent that it is a different planet. Saturn students need to have some sort of rings around their formation to indicate that it is Saturn.]*

*(Ryan and Camilla walk on to stage furthest away from Saturn.)*

**Camilla:** Alright, we tried a planet that was closer to the Sun and that was too hot, let's check out a planet that is further away from the Sun.

**Ryan:** STAN, how far away is Saturn from Earth?

**STAN:** Saturn is about **[how many miles away is Saturn from Earth?]** \_\_\_\_\_ away from Earth.

*(Ryan and Camilla walk towards Saturn)*

**Camilla:** Another thing we talked about that humans need is air. STAN, can you tell us about what Saturn's surface and air?

**STAN:** Saturn is a gas-giant planet and does not have a solid surface.

**Ryan:** Uh oh, how would we walk? Or grow plants? This isn't off to a good start...

**STAN:** Saturn's atmosphere is made of **[what elements is Saturn's atmosphere made of?]** \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**Camilla:** Oh, well I know there is a little bit of helium and hydrogen in Earth's atmosphere, but what is it mostly made of?

**STAN:** Calculating...calculating...unfortunately, I do not have that information.

**Ryan:** Anyone out there know what Earth's atmosphere is composed of?

*(Ryan and Camilla break the fourth wall and look to audience for answers. Audience responses should consist of either Oxygen or Nitrogen. If no one raises their hand, Camilla can speak up and say "Oh I remember, Nitrogen and Oxygen!")*

**Ryan:** *(if someone in the audience answers correctly)* That's right! Nitrogen and Oxygen! Humans need oxygen to breathe, and it doesn't look like we'll find that on Saturn.

**Camilla:** Plus, if there's no solid surface, how would we build shelter? Or grow plants?

**Ryan:** You're right, looks like Saturn doesn't have a chance for life. So now we've tried a planet closer to the Sun and that was too hot, and we've tried a planet that was further from the Sun and that didn't have the right surface. On to the next option I guess.

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### Scene Four:

*[Stage should be set with starry background. Ryan and Camilla are inside the space ship. There should be a table with a laptop/tablet to represent a control table inside their spaceship.]*

*(Enter Ryan and Camilla center stage)*

**Ryan:** Alright STAN, where to next?

**STAN:** You will be traveling outside of our solar system to an exoplanet near Alpha Centauri.

**Ryan:** STAN why would we go to a planet that has a half horse half man on it?

**Camilla:** Ryan, STAN said Alpha CENTAURI, not CENTAUR.

**Ryan:** Ohhh, well first of all, what's an exoplanet?

**STAN:** Calculating....calculating....They did not define exoplanet to me.

**Ryan:** Does one of our friends know what an exoplanet is?

*(Look to audience for answer, answer should be something along the lines of a planet outside of our solar system. If no answers, have Camilla answer and say, "Oh, I remember, Commander Jay Scott told us it was a planet outside of our solar system!")*

**Camilla:** *(if answered by audience)* Right! A planet outside of our solar system. Commander Jay Scott told us that if we couldn't find a planet in our own solar system that might be habitable, we would have to travel to an exoplanet that might be in the habitable zone.

**Ryan:** What's the habitable zone?

**STAN:** [What is the habitable zone? Write a line explaining what it is!]

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As far as we know, liquid water is essential to life.

**Camilla:** Oh, so we're looking for planets that are in the same type of orbit like Earth is in relation to the Sun!

**STAN:** Correct. The exoplanet's orbit must be in the habitable zone like Earth, but in relation to the star that it orbits.

**Ryan:** So, if we're looking for another solar system with a planet like ours, where's the next closest star?

**STAN:** As you know, the closest star is the Sun, which is 93 million miles away from Earth. After that, the next closest star is Alpha Centauri.

**Ryan:** Got it. And you're sure this has nothing to do with a half horse half man?

**Camilla:** I'm positive, Ryan. STAN how far away is Alpha Centauri?

**STAN:** Alpha Centauri is \_\_\_\_\_ [how many light years away is Alpha Centauri?]

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**Camilla:** Wait, light years, what are those?

**STAN:** Light years are measured by the distance light could travel in one Earth year.

**Camilla:** Oh, and light travels pretty fast, as I recall \_\_\_\_\_ . [how fast does light travel?]

**STAN:** Yes, Camilla, great memory!

**Camilla:** Thanks, STAN! So, if Alpha Centauri is \_\_\_\_\_ [how many light years away?] how many miles away is that?

**STAN:** If my calculations are correct, one light year is about 6 trillion miles. This means you would multiply 4.3 times 6, which gives you 25.8 trillion miles away.

**Ryan and Camilla:** (*together*) WOAH.

**STAN:** It is an awfully far way away.

**Camilla:** It is, but we must complete our mission. The people back on Earth are counting on us. We can't let them down. STAN, prepare the course to the closest exoplanet in the habitable zone.

**STAN:** Preparing course. 3...2...1...

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### Scene Five:

Scene is set for the original laboratory set. A large table with laptops or other types of tablets/screens is set stage right for Commander Jay Scott. Other desks with laptops/tablets are stage left, facing the audience, with extra actors sitting at the desks. Extras should be dressed as lab technicians who are working on their laptops. Commander Jay Scott is seated at the large table, facing the audience.

**Commander Jay Scott:** *(slowly rises, looking shocked at the laptop)* Everyone! I have an incredible announcement!!

*(Lab technicians all pause what they're doing and turn towards Commander Jay Scott)*

**Commander Jay Scott:** I have just received word from Astronauts Ryan and Camilla, they have reached the exoplanet in the habitable zone, and things are looking promising!

**Technician #1:** What do the results indicate, Commander?

**Commander Jay Scott:** Well, first, the planet they have found has liquid water on it, which is most essential to life as we know it.

**Technician #2:** That's great!!

**Commander Jay Scott:** It is!

**Technician #1:** But what about the atmosphere? What is it composed of?

**Commander Jay Scott:** It is just like Earth's, mostly nitrogen and oxygen!

**Technician #2:** Amazing! What does the surface look like?

**Commander Jay Scott:** They are collecting samples from the surface now, but it is a solid surface which is good for us humans. We need to be able to

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[what would we need to do to sustain human life? Write a line about that here]

**Technician #1:** I can't believe it, we just might have just found the perfect exoplanet!

**Commander Jay Scott:** This exoplanet does truly provide a lot of hope, but our work doesn't stop here. We need lots of hard workers to help us learn more about exoplanets and the potential for life to exist on them. We will need teachers, doctors, engineers, physicists, businessmen, well, really everyone's help on this project! This is so exciting!

*(Commander Jay Scott turns to audience)*

We need people like all of YOU to help us on our project! Will you help us?

*(Look to crowd for a big "YES!")*

Great! Let's all get to work!!

**END.**