EXPLORING OUR SOLAR SYSTEM (LEVEL 3)

Description	Learners will create their own model of our solar system to showcase the planets and some interesting facts about them
Leading Question	How are planets positioned in our solar system?
Total Time Required	4 hours over 3 days
Supplies Required	Pen/pencil, ruler, color pens, paper, paper/plastic plate, small round object, torch/flashlight
Learning Outcomes	1. Understanding of solar system and position within the Milky Way galaxy 2. Understanding of solar system planets movement in space due to gravity 3. Understanding of average temperature on planets and relation to distance from the sun 4. Understanding of certain topographic and atmospheric features of planets
Previous Learning	- Basic familiarity with planets in the solar system - Operations with whole numbers and decimals up to thousands place

DAY 1

Today you will learn about planets in our solar system.

Suggested Duration	Activity and Description
10 minutes	• Write down a description of a planet. • The earth is one of eight planets. What other planets do you know?
10 minutes	• The planets in our solar system, in the order of how close they are to the sun, are: **M**ercury, **V**enus, **Earth**, **M**ars, **J**upiter, **S**aturn, **U**ranus, and **N**eptune. • One easy way to remember this order is using the acronym formed by the first letter of each planet name - M-V-E-M-J-S-U-N and

remembering the phrase **M**y **V**ery **E**ducated **M**other **J**ust **S**erved **U**s **N**achos!

- Come up with your own phrase to remember the order!

M: ______ V: _______ E: _______ M:_______ J: _______ S: _______
U: _______ N: _______

20-30 minutes

- Numeracy activities:
- The distance of each planet from the sun is as follows:

Mercury: 35 million miles
Venus: 67 million miles
Earth: 93 million miles
Mars: 142 million miles
Jupiter: 484 million miles
Saturn: 889 million miles
Uranus: 1.79 billion miles
Neptune: 2.8 billion miles

Hundred Millions	Ten Millions	Millions	Hundred Thousands	Ten Thousands	Thousands	Hundreds	Tens	Ones
	5	0	2	0	0	5	0	0

- Imagine the Earth is only 93 miles away from the sun instead of 93 million miles. If we were to represent Uranus in an equivalent way, its distance from the sun will be 1790 million miles away since 1 billion = 1000 million. Uranus will therefore be 1.79 x 1000 = 1790 million miles away from the sun. What will Neptune's distance from the sun be in millions?
- Forget for a moment the millions and billions in each planet's distance from the sun. For example, imagine that Earth is only 93 miles away from the Earth. Can you present these figures in kilometers? One mile is equivalent to 1.6 kilometers. Do this for all eight planets.

30 minutes

- Draw the solar system! Arrange the planets in the right order of distance to the sun and keep in mind the sizes and shapes of planets mentioned in appendix 1
- Let's forget about the millions and billions for a moment and scale the distances of each planet down as such:

1. Mercury: 35
2. Venus: 67
3. Earth: 93
4. Mars: 142
5. Jupiter: 484
6. Saturn: 889
7. Uranus: 1.79
8. Neptune: 2.8

- Divide the distances of Mercury, Venus, Earth, and Mars by 10. Using a ruler, draw each planet after the distance you get as an answer. This should be the distance of the planet **from the sun**. (Hint: you should draw Mercury 35/10 = 3.5 cm away from the sun)
- Divide the distances of Jupiter and Saturn by 100 and draw each planet as X cm away **from the last planet**. X is the answer you get by dividing the distance by 100. (Hint: Jupiter should be drawn 484/100 = 4.8 cm away from Mars)
- Multiply the distance of Uranus and Neptune by 10. Draw Uranus X cm and Neptune Y cm after Mars. X and Y are the answers you get by multiplying the distance of each planet from the sun by 10.

Tips:

- Note that the figure you get will not be to scale!
- If your paper is not long enough, you can tape/glue/attach another piece to elongate it for your solar system figure

DAY 2

Today you will learn about how planets move in space.

Suggested Duration	Activity and Description
10 minutes	● On Earth, gravity is what keeps humans, animals, plants, buildings etc. and all living and nonliving things on Earth. It pulls everything down, that's why we don't fly into space! Everything has a gravitational force, but smaller objects have very little force. In our solar system, planets and their moons also have their own gravity.
15 minutes	● Select any two objects in your house that are different in weight - one object must be light like a feather or a small piece of paper, and another has to be heavier like a medium sized-toy, rubber ball etc. ● Make a prediction about which object you think will fall first and why ● Drop both objects at the same time and make a note of what happens. Did the experiment validate what you had predicted?

- Now try dropping a small solid object like a marble or stone and a bigger but hollow object like a basketball, football etc. What happened? Did you predict successfully what was going to happen?

Objects	Hypothesis	Evidence
e.g. marble and football	football lands first	marble lands first
<insert objects>	<insert hypothesis>	<insert evidence>
<insert objects>	<insert hypothesis>	<insert evidence>

10 minutes

- The learner and his or her sibling or other family member will choose two planets to simulate their movements. One of the selected planets must be Venus or Uranus. A third family member can play the sun
- The person who is simulating Venus/Uranus will rotate in one place in clockwise while the other person simulating any of the other planets will rotate in one place counterclockwise
- The person representing the sun will be placed in fixed position in the room and rotate counterclockwise while the two “planets” will start to move around the “sun” slowly and counterclockwise, while still rotating around themselves
- Do this slowly otherwise you might get dizzy!
- The person representing the sun can hold a torch or flashlight representing the sun’s light. Notice how the light falls on some parts of the “earth” and not others. The lit and dim parts change when the earth rotates. This is how night and day are caused. The lit parts of the “earth” are where countries experience day and the dim parts that are turned away are where it is nighttime.
- To demonstrate how seasons are caused, the person representing the “earth” should rotate and revolve around the sun *while* tilted (or leaning slightly to the right). The “sun” should have its light on. You will notice that when the northern part of the “earth” (called the Northern Hemisphere) receives direct sunlight, the lower part (called the southern hemisphere) receives less light. This is why when the Northern Hemisphere experiences summer, it is actually winter in the Southern Hemisphere. The same is true when the order is flipped as the earth continues to revolve around the sun and the Northern Hemisphere is tilted away from the sun, resulting

in winter for the Northern Hemisphere and summer in the Southern Hemisphere!

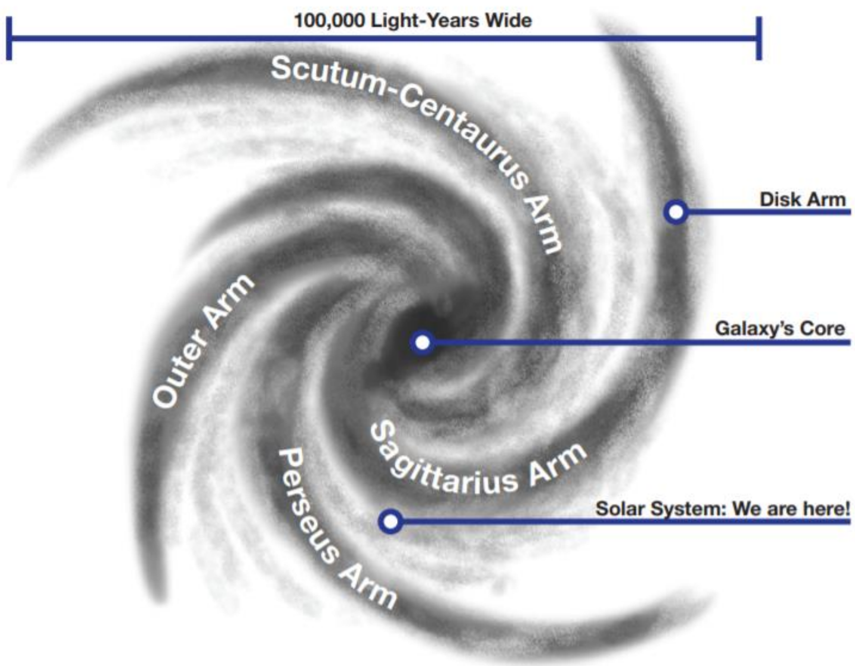
5 minutes

- Take a small ball or round object the size of a grape and a round plate with raised edges like the following

- Place the object in the plate and begin rotating the plate slowly so that the object moves along the edge of the plate
- Imagine that the plate is the solar system and the center of the plate is where the sun is positioned. This is how planets move in a fixed path around the sun!
- If the round object was the Earth, how would it move? What about Venus?
- Reflection questions
  - How long do you think it takes the Earth to rotate around itself? (one day)
  - It takes different amounts of time to complete a rotation - it takes Neptune only 16 hours while Mercury completes it in 1,408 hours! The amount of time it takes to complete a rotation is the equivalent of one day on planets!
  - How long do you think it takes the Earth to revolve around the sun? (one year or 365 days!)

15 minutes

- Planets are not the only heavenly bodies that are in motion. Our entire solar system is in motion.
- The solar system is actually only a small part of our galaxy - called the Milky Way - which is also in motion in space.
- The Milky Way is one of billions of galaxies in our universe, each with their own set of stars and possibly planets (they are too far to detect right now!).
- The Milky Way looks like a pinwheel with 4 major arms as shown in the image below. The stars are arranged in each arm. We live on one of these arms!



source: https://www.education.com/download/worksheet/117338/the-milky-way.pdf

1-2 hours	● Optional: let's try to spot some star constellations! ● Make sure the night sky is clear (i.e. no rain, clouds etc.) ● Sit outside for 1-2 hours and try to spot one of the following constellations ● Some planets called bright planets are also visible just after sunset! Try to see if you can spot some objects that do not twinkle like stars! some planets also have colors: Mercury can look brown/gray, Mars looks red, Venus looks yellow ● If you are unable to find constellations, create your own! Draw the pattern you observe on a piece of paper and give it a name! You may even take a picture of it! ● Tip: if you record a video of the night sky for 5-6 hours, you can see the stars and some planets moving across the sky!

Source: https://www.eurekacamping.com/blog/article/5-constellations-everyone-can-find

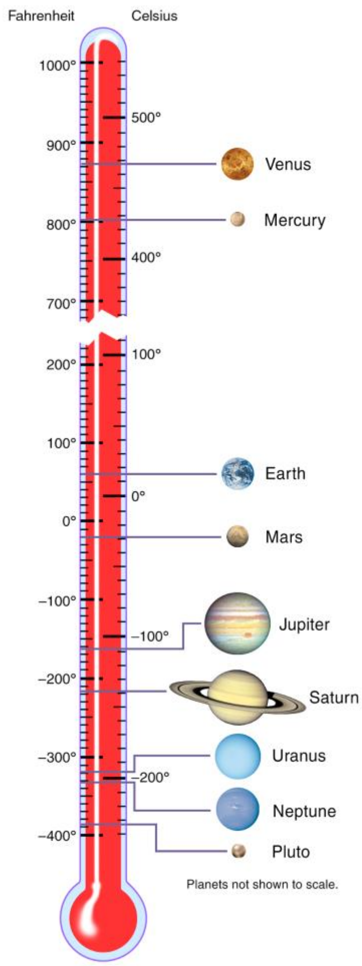
10 minutes	● Draw and label a “zoomed in” image of the Milky Way focusing on the arm that our sun and solar system are in. Draw and label the arm, solar system and all the planets and heavenly bodies in it. Try to do this from memory!
10 minutes	● Numeracy activities: - You just discovered a new planet that is very far from the sun! It takes this planet half the time it takes Earth to complete one rotation. How many hours does this planet complete one rotation around its axis? (Hint: 1 day = 24 hours)

	- It takes Uranus 84 years to complete one revolution around the sun (also called a year), but it takes Jupiter 1/7th of this amount of time to complete it. How long is a year (or orbital period) in Jupiter? - A fictional planet travels at an average speed of 800 km per hour. At this rate, it would take it about 230 hours to travel all the way around the sun. What would be the total distance covered by the planet in that amount of time? (hint: distance = speed x time)

DAY 3

Today you will plan a vacation for your family on one of the planets in our solar system!

Suggested Duration	Activity and Description
10 minutes	● Recall each planet's position with relation to the sun. How hot or cold do you think it is on each planet? Think about the weather on each planet. What planet do you think would be the hottest? Think, then look at the image below:



source: https://solarsystem.nasa.gov/resources/681/solar-system-temperatures/

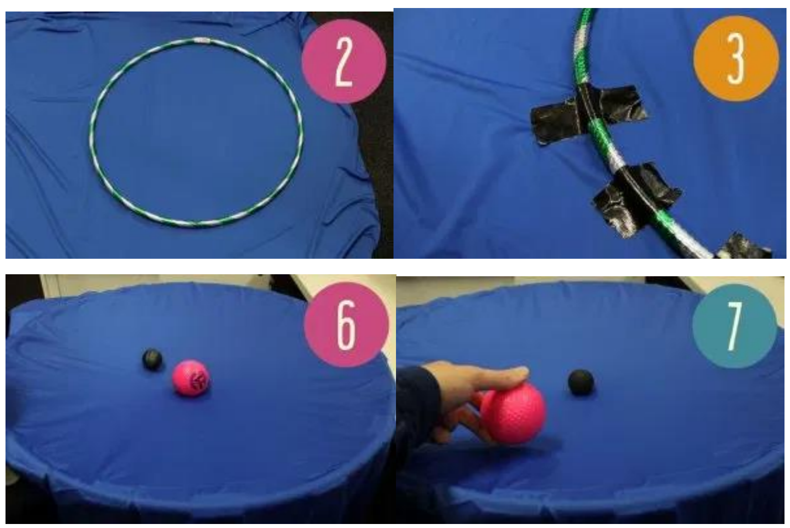
30 minutes

- Numeracy activities:
  - Let's see if it's true that in general planets that are farther from the sun are colder. Recreate the figure above in a number line from -300 to 500 (representing degrees celsius) and write down the name of each planet under their average temperature. Mark each point indicating the temperature of a planet in a different color and write the name of each planet in that same color as the point on the number line. Now, underneath each planet's name, write a number indicating the order of planets in relation to the sun. 1 should go under Mercury, 2 under Venus etc. What can you conclude? Is it true that planets farther away from the sun are colder?
  - Let's find out how hot our solar system is collectively! Add all the temperatures of the planets to find the answer, making sure you pay attention to planets with negative average temperatures!

- Using the information above, calculate how much hotter Venus is compared to Earth? (Hint: divide the average temperatures of Earth, which is 14 degrees celsius, and Venus, which is 462 degrees celsius, to find the answer.)

20 minutes

- Every object has a gravitational pull, even the moon. Did you know that the Earth is not the only planet with a moon? Refer to appendix 1 to see how many moons each planet in our solar system has! Let's do a short experiment to simulate how gravity works between a planet and its moon:
  - Make a large circular cutout of a circular border. You can also use an object like a hula hoop, or make a circle using a hanger or other metal wire
  - Lay a large piece of stretchy fabric like polyester on the floor and place the circle you made on top of it and tape it to fabric as shown below:



source: https://apollo11.csiro.au/resources/educational-activities/gravity-well/

  - Flip it over then place a small heavy ball (like a tennis ball) in the center and a smaller ball (like a marble) around the edge and try to make the lighter ball rotate like you did in yesterday's orbit experiment. What do you observe?
  - Now place the lighter ball in the center and the heavier ball at the edge and try to make it rotate. What do you observe?
  - Think of the heavier ball as a planet and the lighter smaller ball as a moon. The dent created by the balls is the gravitational field of each object in space. This is larger for bigger objects like planets because their gravitational pull is stronger. Moons orbit planets because of planets' strong gravitational force. In fact, both of Mars' moons are smaller planet-like rocks (called **asteroids**) that Mars captured and made them orbit it!

- The smaller ball (moons) do not have the same effect on larger balls (planet). Sometimes, lighter objects can be flung wildly into space as a result of coming into contact with a heavier object! Scientists think that our own solar system could have flung millions of planets into outer space. These are called rogue planets!

5 minutes

- Time to plan your outer space vacation!
- What makes a good outer space vacation?
- Suggestion on criteria for a good outer space vacation:
  - We should be able to walk on the ground (solid surface) so we can go for walks
  - We should be able to get a nice view of the sun to see the sunset

10-15 minutes

- Using appendix 1, pick a planet and develop a trip plan to share with your family using the template below. Write down an activity you would like to do with your family and provide a feature of the planet that will allow you to do this activity. An example has been done in the template below:

Planet name	<insert name>
Travelers	<insert names of family members>
Day	***Activity***
1	Example: On the first day, we will settle down then go for a long walk. This planet rotates once every 11 hours, so we will see the stars move faster than they would on Earth as the planet rotates!
2	<insert activity>
3	<insert activity>

- Share the trip plan with your family and see what they think of your plans!

ASSESSMENT CRITERIA

- Correct understanding of planets in the solar system and each planet's position in the Milky Way
- Correct understanding of heavenly bodies movement in space and topographical features

- Completion of outer space vacation itinerary with facts about each planet

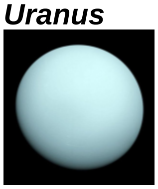
ADDITIONAL ENRICHMENT ACTIVITIES

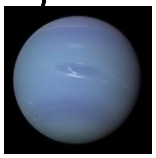
- Explore the concept of a light year - a unit of distance that expresses how far light can travel in a year. Light can travel almost 300,000 km per second. Calculate how much it can travel in a year to get the estimate for a light year. (Hint: there are 86400 seconds per day and 365 days per year!). Can you write the figure in a place value chart? (hint: it's in the trillions, which comes after billions)

MODIFICIATIONS FOR SIMPLIFICATION

Learners can write an essay on the different planets in our solar system detailing how they are positioned in relation to the sun and how they move in space, and draw a figure of the milky way and our solar system. Learners can do the experiments on days 2 and 3 to demonstrate the concepts of rotation, revolution, gravity, night and day and seasons.

APPENDIX 1

Planet	Temperature (approx.)	Atmosphere and surface	Moons
Mercury 	465 ° Celsius in the morning and -184°C at night!	No atmosphere (no air). Mercury has a range of mountains called Caloris Montes extending more than 1000 km	0
Venus 	470 °C (it is the hottest planet!)	Thick atmosphere of carbon dioxide and sulfuric acid. It has four main mountain ranges - Maxwell Montes, Frejya Montes, Akna Montes, and Danu Montes.	0
Mars 	0°C in the morning and -100 °C at night!	Thin atmosphere. Mars has the tallest mountain in our solar system called Olympus Mons (21.9 km)!	2 - Phobos and Deimos
Jupiter 	-110 °C	Gas giant made up of hydrogen and helium with no solid surface to stand on!	79 confirmed moons!
Saturn 	-176 °C	Gas giant made up of hydrogen and helium with no solid surface to stand on!	53 official moons!
Uranus 	-217 °C	Ice giant made up of hydrogen and helium with no solid surface to stand on!	27 mons in total with 5 major moons - Miranda, Ariel, Umbriel, Titania, and Oberon.

Neptune 	-217 °C	Ice giant made up of hydrogen, helium and methane with no solid surface to stand on!	14 moons