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Inspiring a new generation to love Science, Technology, Engineering and Maths

at home

The final frontier

Due to technological advances, it won't be long before humans are planning crewed missions to the moons of distant planets in our Solar System.

As part of the team, you need to first help get the rocket to the right place by gradually improving our model of the Solar System. Then you need to make sure that the crew will be able to survive on arrival. They will need oxygen to breathe, food to eat and shelter.

Physics		Map the Solar System
Technology		Model the Solar System
Maths		Investigate ellipses
Chemistry		Investigate atmospheres
Biology		Investigate plant life
Engineering		Create a shelter

We would love to see photos so please share with #CSGatHome.

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Map the Solar System

Story

Due to technological advances, it won't be long before humans are planning crewed missions to the moons of distant planets in our Solar System. As part of the team, you need to first help by mapping the Solar System.

Equipment

- Long strip of paper (e.g. cut a piece of A4 into 4 vertical strips and stick them together)
- Pencil
- (optional) Colours

Instructions

- Label one end of your strip Sun and the other Pluto.
- Fold the strip in half. Label this fold Jupiter.
- Fold the strip in half from the Sun to Jupiter. Label this fold Asteroids.
- Fold the strip in half from the Sun to the Asteroids. Label this fold Mars.
- Squeeze in Mercury, Venus and Earth between the Sun and Mars.
- Fold the strip in half from Pluto to Jupiter. Label this fold Uranus.
- Fold the strip in half from Uranus to Jupiter. Label this fold Saturn,
- From the strip in half from Pluto to Uranus. Label this fold Neptune.

Glossary

Your map contains one star, eight planets, one dwarf planet and some asteroids. Which is which?

star – a large spherical object that releases energy from nuclear fusion.

planet – a spherical object that has a clear orbit around a star.

dwarf planet – a spherical object that has not cleared its orbit around a star from other material.

asteroid – a non-spherical object that orbits a star.

Your mission is to visit a moon.

moon – a natural satellite that orbits a planet.

Questions and Research Ideas

- In our model, all of the planets are lined up. How could you improve this model?
- Create a fact file for each planet:
  - average distance from the Sun
  - length of a year (complete orbit of Sun)
  - length of a day (complete rotation on axis)
  - average daytime and night time temperature
  - number of moons

Further tasks

- Model the Solar System
- Investigate ellipses
- Investigate atmospheres
- Investigate plant growth
- Create shelter

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Model the Solar System

Equipment

- objects to model Solar System objects e.g. balls, cups or people!
- website: scratch.mit.edu

Instructions

- Use two objects to model the motion of the Earth and Sun. Write a list of instructions for this motion.
- The force of gravity pulls the planet towards the Sun. The planet is not pulled in because it moves perpendicular (at 90°) to this force. Therefore our sprite needs to:
  a) point to the Sun
  b) Turn 90°
  c) move
  a) point to the Sun

- Choose a sprite to represent the Earth and the Sun. Do you need to change their size?
- Now write your code. You might need these blocks:

If you are new to scratch, try remixing this project:
https://scratch.mit.edu/projects/399509099

Questions

- Use the pen tool to check that your planet is not spiralling out of orbit? How could you prevent this?
- Can you add a background to make it look like space?
- Can you add more planets? Should they move faster or slower?
- Why is it more difficult to add the Moon?

Story

Our map of the Solar System showed all of the bodies in a straight line. We need to refine this model to show how the bodies move. If we are to reach the moons of the gas giants, we will need to time our mission so that they are as close to Earth as possible - definitely not on the other side of the Sun!

Glossary

A computer simulation is a program which attempts to mimic a real-life scenario.

As the Solar System is very complicated, we need to decompose the process into smaller chunks. (e.g. the Earth and the Sun)

Having recognised some patterns, we need to use the process of abstraction to decide which features to include and what to ignore.

Finally, we can write an algorithm or list of instructions.

Further tasks

- Map the Solar System
- Investigate ellipses
- Investigate atmospheres
- Investigate plant growth
- Create shelter

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Investigate ellipses

Story

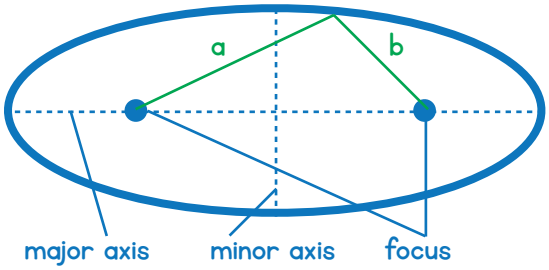
Our computer simulation of the Solar System showed the planets orbitting the Sun in circles. Actually, the orbits are slightly elliptical. This changes the orbit times. If we are going to reach our destination safely, we need to refine or improve our model.

Equipment

- 2 nails, sewing pins or drawing pins (the longer they are, the easier it can be to draw)
- cotton or string
- sharp pencil
- paper
- wooden or cork board (or use corrugated cardboard with sticky tack to support the pins)

Glossary

An ellipse is a regular oval where the sum of distances from each focus to the edge is constant all the way around: a + b = constant



The major axis is the longest diameter (a line from one side to the other that passes through the centre).

The minor axis is the shortest diameter.

Instructions

- First, let's draw a circle. Tie a loop in either end of your string.
- Pin one end to the paper and put your pencil in the other end. Pull the string tight and draw a circle.
- For ellipses, pin each loop to the paper so the string in between is loose.
- Using your pencil, push the string out until it is taut.
- Draw a complete circuit. You may need to do this in two stages. Remember to keep the string tight.
- Move each pin 1cm toward the other and repeat.

Questions

- Can you draw the major axis?
- Is there a relationship between the length of the major axis and the length of the string?
- Can you draw the minor axis?
- Is this sometimes, always or never true: The minor axis is half way between the pins (focus)
- In the Solar System, where would the Sun be?
- What do perihelion and aphelion mean?
- Research Johannes Kepler. What did he discover?

Further tasks

- Map the Solar System
- Model the Solar System
- Investigate atmospheres
- Investigate plant growth
- Create shelter

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Investigate atmospheres

Story

We now know how to get to the distant moon but we need to know whether we will be able to survive when we get there. We will need oxygen. By observing how light behaves when it travels through the atmosphere, we can predict and identify the density of particles.

Equipment

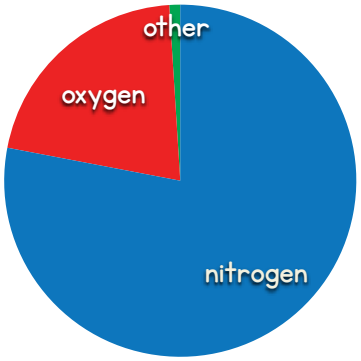
- 3 clear straight sided glasses or jars
- water
- milk (skimmed or diluted)
- particles (e.g. dettol, powdered milk or flour)
- 1 teaspoon
- 1 torch
- a dark room – the darker the better!

Instructions

- Fill 1 glass with milk and 2 glasses with water. To one, add a few drops of particles and stir.
- Shine the torch through the side of each glass. Can you see the beam? We can when large particles scatter the light.
- Shine the torch through the back of the third glass. Slowly add more particles. Observe any colour changes. Does the angle at which you look matter?

Glossary

The gases around a body (e.g. a planet) make up its atmosphere. The Earth's atmosphere is made up from nitrogen (78%), oxygen (21%) and other gases including argon (0.9%) and carbon dioxide (0.04%).



Questions

- How can these experiments tell us about the atmospheres of distant moons?
- What are solutions, colloids and suspensions?
- How do scientists think the composition of Earth's atmosphere has changed over time?
- Which processes remove carbon dioxide from the atmosphere? Which processes add carbon dioxide?
- What gases make up the atmospheres of Saturn's two largest moons: Titan and Rhea? Could humans live there?

Further tasks

- Map the Solar System
- Model the Solar System
- Investigate ellipses
- Investigate plant growth
- Create shelter

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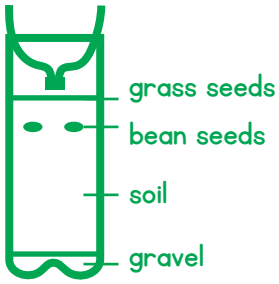
The final frontier
Investigate plant life

Equipment
- 2 litre plastic bottle with its lid
- scissors
- strong sticky tape
- gravel or small stones
- soil or compost
- 4 bean seeds
- grass seeds
- 20 ml water

Instructions
- Carefully cut off the top of the bottle 10 cm from top
- Put in 2 cm of gravel
- Add 10 cm of damp soil
- Put in bean seeds and cover with 2 cm of soil
- Sprinkle grass seeds on top
- Add water
- Replace the top of the bottle but upside down.
- Seal with tape and leave somewhere warm and light.

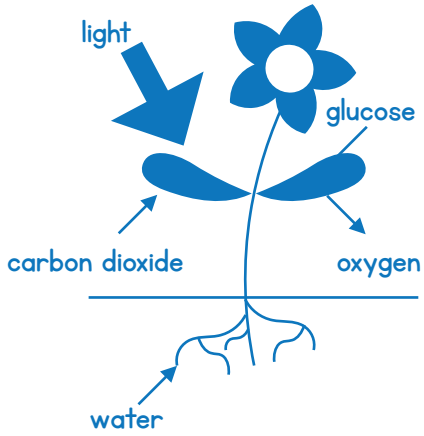


Questions and Research Ideas
- Keep a photo diary of your terrarium
- Predict how the mass will change. Record the mass every day and see if you are correct.
- How could you measure growth?
- Is soil necessary for growing plants?
- What happens if you fill the inverted top with ice?
- What plant experiments have been done in space?

Story
Plants will be very important on our mission. We will need them not only for food but also to produce oxygen for us to breathe through photosynthesis. Plants need water but that is heavy and we need to take as little as possible if our rocket is going to successfully launch.

Glossary
Photosynthesis is the process used by plants to transfer light energy from the Sun into chemical energy.

carbon dioxide + water → glucose + oxygen



Further tasks
- Map the Solar System
- Model the Solar System
- Investigate ellipses
- Investigate atmospheres
- Create shelter

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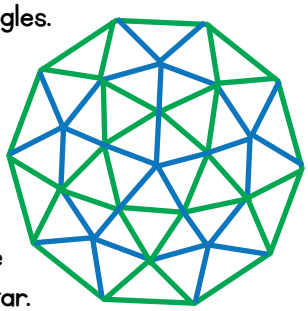
Create a shelter

Equipment

- 35 long tubes and 30 short tubes
  You could use straws (35 x 13 cm and 30 x 11 cm) or tightly rolled paper (35 x 30 cm and 30 x 26 cm). (It helps to use different colours or to mark them so you know which length is which.)
- tape and scissors

Instructions

- Make a ring with 10 long tubes. Connect with tape.
- Alternate between 2 short and 2 long tubes to make a repeating pattern of triangles.
- Connect the 10 triangles with short tubes.
- Where 4 short tubes meet, connect another short tube to make a star.
- Use 2 long tubes to complete the pentagon around each star.
- Connect the next layer with a central pentagon of long tubes.
- Use 5 short tubes to make the pentagon into 5 triangles



Questions

- What different shapes can you see in your dome?
- What was the hardest part about working in a team to build this dome? (The astronauts must practise!)
- Does the size of the dome affect its strength? How could you test this?
- What is the weakest part of this dome? How could you improve this?

Story

As soon as the astronauts arrive, they will need to construct a shelter. A geodesic dome is made from lots of triangles. It encloses a large volume using as few materials as possible, which is good because we cannot take much in our rocket. It is also strong because the load is shared between the triangles.

Glossary

Geodesic means the shortest line between two points on a curved surface.

Research Ideas

- For a shelter, what else is needed? How would this affect the strength?
- How can you make the dome waterproof?
- To calculate the number and lengths of tubes needed for larger or more complicated domes, visit desertdomes.com/domecalc.html

Further tasks

- Map the Solar System
- Model the Solar System
- Investigate ellipses
- Investigate atmospheres
- Investigate plant life