Creating Science – The Moon

Earth's nearest companion and oldest friend, what science secrets do you hold, Mr Moon?

#CreatingScienceTheMoon

Suggested outcomes

(This is by no means an exhaustive list of possible outcomes, neither is it intended that ONLY these outcomes can or should be met. Science is a deeply interrelated activity, and you may find cross curriculum links you can and should use.)

Science understanding

- Earth and space sciences 3: Earth's rotation on its axis causes regular changes, including night and day.
- Earth and space sciences 5: The Earth is part of a system of planets orbiting around a star (the sun).

Science inquiry skills

- Communicating 3: Represent and communicate observations, ideas and findings using formal and informal representations (ACSIS060).

Science as a human endeavour

- Science as a human endeavour 9 & 10: Advances in scientific understanding often rely on developments in technology and technological advances are often linked to scientific discoveries. (Though, really, this can be taught in grade 2).

Cross curricular outcomes

Visual arts: Years 5 and 6 Content:

- Develop and apply techniques and processes when making their artworks (ACAVAM115).
- Plan the display of artworks to enhance their meaning for an audience (ACAVAM116).

Science vocabulary words

Tier 1 (Everyday words) - moon, space, sun, stars.

Tier 3 (Specialised vocabulary)

- Rotate – to spin around oneself, like a child getting dizzy.
- Revolve – to spin around something else, like a child running around in circles.
- The "dark" side of the moon - there is no dark side of the moon, it rotates just like the earth does, with a day and night cycle. However, one side always faces away from Earth. This is sometimes referred to the dark side, but it is more accurately referred to as the far side of the moon.

Warning

- Paint, drawing implements, and small balls. Be wise and use appropriate caution.

Preparation

- Prepare your own model of the earth and moon before you begin. Make sure you have a representation of the two sides of the moon – the near and the far side.

Suggestions for other year levels

As always, more material is presented here than can be used by the average class during the average lesson time. However, since the students' questions can and should guide student learning, more material is presented for your convenience. Remember, it is not uncommon for students to only remember those points which answered their personal questions.

Younger:

This activity is well suited to this age group.

Middle:

Simple extensions are easy to incorporate in this activity, including:

- Drawing out a monthly map of the moon cycles. Pick the same time each day and draw the moon. You will learn the moon does, indeed, come out during the day. Also, that the whole moon is there all the time, we just can only see the part that has light shining on it.

Teen:

Complex extensions include:

- Mathematically comparing tides to moon position. Does the moon really help to cause the tide? Prepare a table of both measurements over several weeks and compare positions (or be truly determined and use regression analysis).
- Calculate the gravitational pull of the sun on both the earth and the moon, and compare these with the gravitational pull of the earth on the moon. Which has the greatest gravitational pull on the moon – the sun, or the earth? The answer may surprise you. Some scientists think we should not call the moon Earth's moon, because it's really just a binary planetary system caught up in each other's gravity and both orbiting the sun. What do you think?

Learning Intent (student friendly)

'We are learning to' (WALT): demonstrate how the sun, moon and earth move relative to each other.

Success criteria

'What I'm looking for' (WILF): students are able to show day and night, eclipses, seasons and a year.

Student learning goals

Help students make a self-monitored learning goal for this lesson, such as;

- Find out if we can see the moon during the day.
- Find out why the moon appears to change shape over several nights.
- Explore why the face of the moon never seems to change.
- Find out why the moon has so many craters.
- Find out what the moon is really made out of.

Evidence of learning

How will you know when the learning goal is achieved? What EVIDENCE do you have that your students have met or exceeded the learning expectations?

Engage

⇨ Make sure all students write down any questions they may have generated during this phase regarding the topic for today.

Bring in some pictures, paper cut outs, or 3D models of the moon. Allow students to discuss the objects, and write down any questions they may have. You might want to engage them in a KWL (see Assessment: prior learning) activity.

1- Ask students what they already KNOW about the topic of the moon. Write it down as a group, or have them draw pictures of their knowledge and ideas.
2- Brainstorm, as a group, the things the students WANT TO KNOW about the moon – that is, write or draw any questions they may have. Remember as a brain storm it's not important to answer those questions yet, and there are no stupid questions when creativity is the goal! After the brainstorm, you can then cull the list of questions with a focus on the kinds of questions that science can help with.
3- At the end of the unit, write, or draw, what you have LEARNED about the topic. What was new information to each of the students? Were they surprised to know the moon does come out during the day? Did they gasp at the realisation that the moon turns around so that it is always facing the Earth?

Being prepared to write down what they have learnt helps students to focus on their own learning, and is thus a metacognitive strategy that can help them learn how to learn, and be better prepared to structure their own learning goals in the future.

Explore

⇨ Encourage and validate student explanations of this phenomenon. You may like to ask students to write or draw their explanation personally to avoid embarrassment to students

unfamiliar with this material. Remember, 'I don't know' is a valid explanation in science – it is the beginning of learning new things!

Try to set up and demonstrate the movement of the moon around the earth.

You can find some good videos online, or do so by having one student hold a model Earth, and having them demonstrate how the moon moves around it – however, the very tricky part is having the student with the moon make sure they face the same side of the moon towards the Earth at all times. Invariably the moon student, or the moon model itself, will have to turn around in order to go around the earth AND keep the same side of the moon always pointing at the Earth.

Explain

Share some or all of the following ideas about the moon, and allow students to debate and discuss them.

- The Earth is in space, floating along because floating along is what things do unless something pushes or pulls them. The earth goes around the sun, this makes up a year. And, of course, the earth rotates around, and this is what makes up the days.
- Meanwhile, the moon goes around the Earth, and this helps to make up the months (since it takes about 28 days for the moon phases to repeat).
- The moon is made of rocks, and is very far away.
- The Moon turns around on its axis just like earth does, and so the moon has days as well. However, its day is 28 times longer than Earth's and, because of gravity, happens to be almost exactly the same length as it takes for the moon to go around the Earth. This means that one side of the moon – the same side at all times – is facing towards Earth.
- Thus we can say the moon has 'two sides'.
    - The "near side" of the moon is the side always facing the Earth.
    - The "far side" of the moon never faces towards the Earth[1], but we know what's there because we've sent spaceships and satellites to find out. We used to call the far side the dark side, but that was a terrible mistake, because it's no darker than any other part of the moon, the far side has day and night just like the near side.[2]
- The "far side" of the moon has many craters, because it's been hit by loads of **asteroids** over its long history (4.5 billion years or so). We're kind of lucky, as a planet, that we have such a

[1] Why? Because of gravity – the earth's pull on the moon creates a kind of tide which has locked the moon into looking at us all the time. On the other hand, the moon's gravity causes tides on earth, which is slowing the earth down about 2.3 milliseconds per century since the 8th century BC. In the far distant future, Earth will be stuck looking at the moon as well – and the moon will not seem to move from its point in the sky at all.
[2] Certain well-meaning science fiction movies have caught on to this idea, and perpetuate the myth that the moon has a dark side we have difficulty seeing. Truth is it's just as difficult as seeing any other part of the moon, we just can't see it from Earth, and it's definitely no "darker" than any other part of the moon.

nice, big, moon nearby. There's a good chance it has helped to protect the Earth from some dangerous asteroids by taking the beating itself.

- The "near side" of the moon has been hit by just as many asteroids over time of course. However, the moon long ago, like earth now, had a liquid mantle. Lava once flowed on its surface, covering up many of the earliest meteorite impacts. These long ago cooled down to form wide plateaus of solid stone. Oddly, these long plateaus were called 'seas' (or 'mar') by the first man of our culture to look at them through a microscope (Galileo from Italy, incidentally). The name has stuck, of course, but there aren't any water seas on the Moon!
- Earth has lots of natural weathering processes, such as wind and rain, to help cover up the craters over the centuries. However, the moon has practically no atmosphere, so there's no wind or rain. So the craters can last thousands, or even millions of years, until new meteorite impacts cover up the old ones.

Don't make the mistake of calling the far side the 'dark side'. It's inaccurate and confusing – but that's language for you.

So why are there only mare (the lunar 'seas') on the near side, and not on the far side of the moon? See next section:

Elaborate

The answer is gravity.

As you can see from the section in Creating Science on forces, all forces are in pairs.

So the Earth is pulling on the moon, otherwise it would fly away into space. Thus the moon is pulling on the earth, that's what causes the tides. But the Earth's pull on the moon gives it some tides as well. Now rock does not move very much, but long ago, when liquid magma poured under the surface of the moon, it was pulled in the direction of the Earth. Thus the near side of the moon has wide, volcanic plateaus we call 'seas', and the far side does not.

⇨ Ask students if they can design new ways to test this explanation, is it really sufficient? Can they think of further or better explanations, and the experiments needed to test them?

Gravity also explains why the Moon is always facing the Earth. The tug of the Earth on the moon slowed it down till it faced us all the time. In the same way, the tides caused by the moon are slowing the Earth down as well, till in a few million years the average day will be 25 hours long. Fascinating!

⇨ Allow students to play with and explore the moon moving around the Earth model. What effect would certain changes have?

Cool videos

https://www.youtube.com/watch?v=j91XTV_p9pc – why the moon faces the earth, and tides.

Debunking Moon Myths

Make an event, or plan a project, around proving (or disproving) some famous moon myths. This is a great way to experience scientific knowledge as requiring argument and evidence, not just belief in expert opinion.

- The moon is made of cheese – this is a lie we tell to little kids to amuse ourselves. Scientists have travelled to the moon, and you know what they found? Rocks, pretty much the same rocks as we have here on earth.
- The moon landing was a conspiracy – the thing about a good conspiracy is that it never goes away. Any evidence for the conspiracy theory is taken as support of the theory, and any evidence against the conspiracy theory is taken as support for the conspiracy. So it is a lot harder to disprove a conspiracy theory. However, some very solid science has gone behind the debunking of the moon myth. You'll have more luck convincing some people the earth really is flat.

Gravity and the moon

There are other examples in the universe where gravity not only causes an object to revolve (as in a planet around a sun), but where it also causes changes in revolution. Mercury is a good example, locked into a 3/2 motion around the sun. Can you think of any other examples from our solar system and beyond?

Evaluate

- ⇨ Review with students what they felt they learnt from this lesson. Did they have any questions at the start that they feel were answered?

Success criteria

- ⇨ Review the Learning Intentions of this lesson with students. Was it met?

At the end of each class, review the learning objective and see how we did. Ask:

- ⇨ Did you achieve your learning goal?
- ⇨ What did You learn?
- ⇨ What worked to help you achieve it?
- ⇨ What might you do better next time?
- ⇨ (If needed) where can you go for extra help or information?

Assessment

Prior learning:

Try a KWL activity;

- At the start of the unit, during the Engage phase, have students write down what they already feel they KNOW about a topic. They can draw it in their books, or you can write it all down on a big sheet of paper as a class.
- Next, on another sheet of paper, have students draw or write down their questions about the topic, that is what they WANT to know about the issue. All sincere questions are welcomed here, and while students may want to suggest answers remind them that scientists look for formal references when creating knowledge.
- Then, during the unit or series of lessons, have a place where students can write down or draw what they LEARNT about the topic. You might like them to write that down every lesson, or have a sticky note or white board where students can put up their learnings every time they happen. This is something that can be celebrated during and after the unit – see if something we KNOW has changed, or if anything we WANTed to know was created.

A focus on what students didn't know at the start of the unit is not as important for their final results – but it is particularly helpful to you as a teacher know what to teach, and to help you choose what experiences are most important for them to learn from.

Finding out what they need to learn about is one of the most important things that Prior Learning evaluation is all about.

Formative:

Listening to students' discussions during the activity, and observing how they move the Earth and Moon models, is also helpful.

Can students demonstrate the tidally locked motion of the moon relative to the earth? [It always points towards the earth.]

Summative:

Have students present a model of the moon, with the 'near' and 'far' sides purposefully illustrated with craters and maria (the plural of the lunar seas, called mar). You can have them demonstrate the relative motion as well - remember, the moon goes around the earth about 12-13 times in a year.

Encourage older students to engage in the debate about moon conspiracies. This helps hone their reasoning and argumentation skills, as well as their scientific literacy and appreciation for what it takes to create scientific knowledge.

So what?

The earth, sun, and moon all move to create night, day, seasons, and phases of the moon.

The 'dark' side of the moon really should be called the 'far side of the moon.

Creating science

Science understanding

As we learnt about day and night, the phases of the moon, the sides of the moon, and the relative motion of the moon and the planets we saw that;

- Earth and space sciences 3: Earth's rotation on its axis causes regular changes, including night and day.
- Earth and space sciences 5: The Earth is part of a system of planets orbiting around a star (the sun).

Science inquiry skills

In building our own moon model to share and explain, we had the chance to:

- Communicating 3: Represent and communicate observations, ideas and findings using formal and informal representations (ACSIS060).

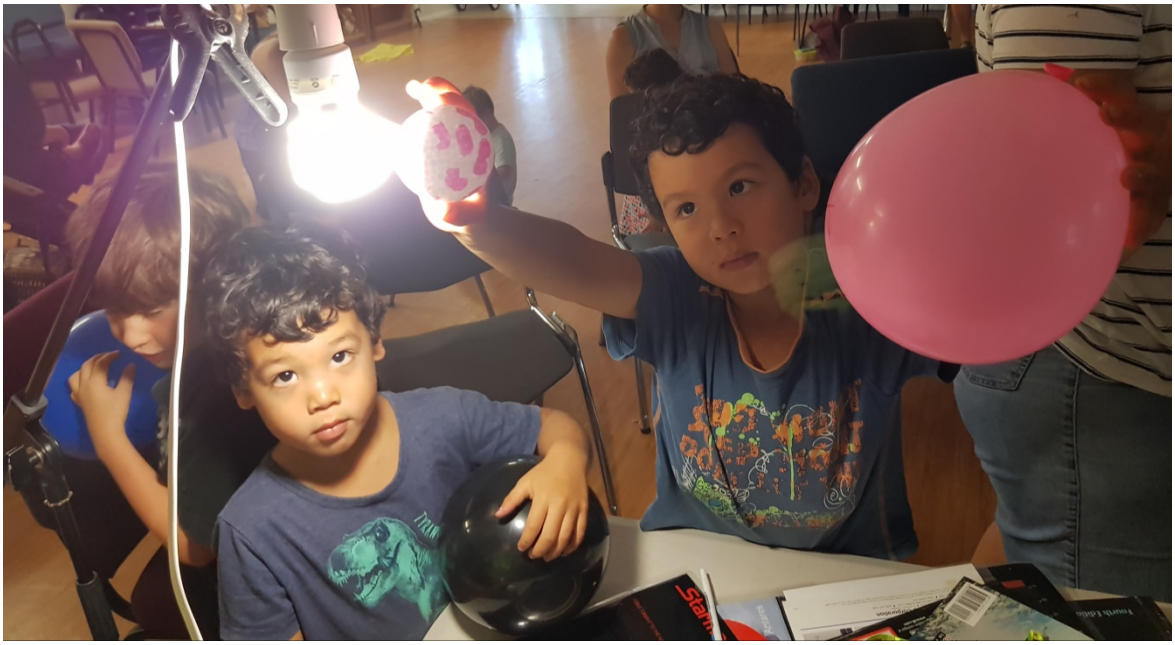
Science as a human endeavour

Though developments such as the telescope, Galileo saw and named the dark patches on the moon 'seas'. As telescopes have developed, and we even developed the technology to go to the moon, we saw that:

- Science as a human endeavour 9 & 10: Advances in scientific understanding often rely on developments in technology and technological advances are often linked to scientific discoveries.

Tips from the Masters to make it work:

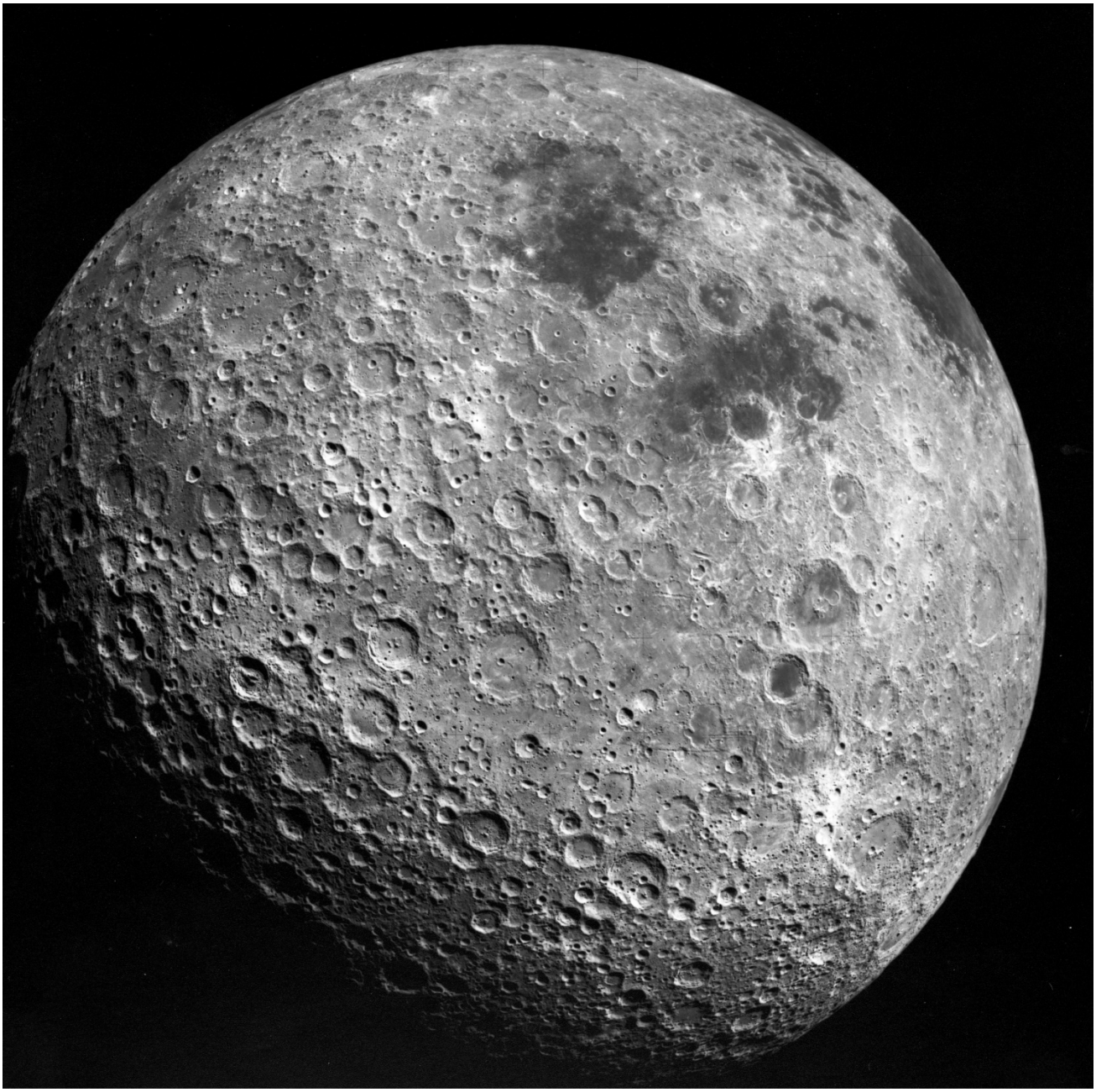
Carefully drawing moon craters!



What does a solar eclipse look like? Use your moon to cast a shadow on your 'earth'.

Appendix:

The ‘far’ side of the moon – note lots of craters, many of them millions of years old!



From Wikipedia 2016

The ‘near’ side of the moon. Note: lots of ‘seas’.

From Wikipedia 2016