

A User's Guide to Space

LESSON OUTLINE / SCRIPT

Introduction

- *Who I am*
- *What I do*
- *Aim of the lesson: to tell you something about the way we use space, including how it affects you every day!*
- *Content of the lesson: a bit about actually sending humans into space; a bit about the machines we have sent into space and what they can tell us; a bit about how we rely on space to make our lives easier; and a bit about the future.*
- *Each section starts with a quick quiz – just for fun!*

Section 1: “Exploring Space” - A brief history of human spaceflight

Exploring Space Quiz (circle the right answer)

1. How many people have walked on the Moon?

8 12 20

Answer: 12

Fun Facts: The only space missions to put people on the Moon were the Apollo missions from 1969 – 1972. Each mission landed 2 people on the Moon. There were supposed to be 10 lunar missions (Apollos 11 to 20), but this was cut back to 7 to save money, and one of those (Apollo 13) had a very serious in-flight emergency and was not able to carry out their planned landing. Although the astronauts did all make it back to earth and there's a great movie as a result!

2. How many years have people been living on the International Space Station?

20 22 25

Answer: 20

Fun Facts: The first crew entered the ISS on 2nd November 2000 and it has been continuously occupied ever since. This means that for over 20 years the whole of the human race has never all been on Earth at the same time! Over 240 astronauts from 19 different countries have lived and worked on the ISS in that time. The person who has spent the most time on the ISS is American astronaut Dr Peggy Whitson.

3. How many British astronauts have there been?

None 2 5

Answer: 2

Fun Facts: A lot of people will recognise Major Tim Peak, who was on board the International Space

Station in 2015 and 16. But the first astronaut to fly with a British flag on their spacesuit was Helen Sharman who visited the Russian Space Station 'Mir' way back in 1991. There have also been two 'Space Tourists' (who paid for trips into space) and five American astronauts who held dual US/UK citizenship.

Exploring Space Highlights



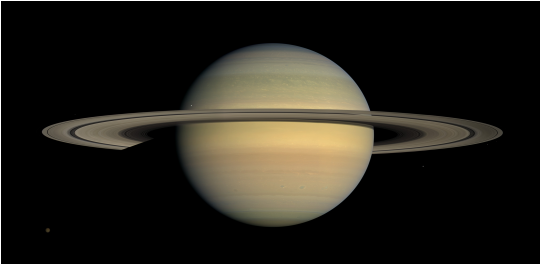

The first human to leave the earth and fly in space was the Russian astronaut (the Russians actually call their astronauts 'cosmonauts', but it's the same job!) Yuri Gagarin. His spaceflight took place in 1961. For the next 9 years the Russians and Americans competed with each other for a string of space 'firsts': the first woman in space (another Russian – Valentina Tereshkova in 1963); the first spacewalk (where an astronaut actually leaves their spacecraft wearing a spacesuit) and increasingly complicated spacecraft and missions. The Americans eventually won the 'Space Race' by placing the first people on the Moon in 1969.

Since the last Moon mission in 1972, human spaceflight has been limited to trips into orbit around the earth. This has developed from very short missions in small spacecraft to the huge (109 x 73 metres – that's as long as a football pitch and quite a bit wider) International Space Station, where some crew members have stayed for over a year at a time.

Human spaceflight allows us to carry out scientific experiments in weightlessness that simply couldn't be done on earth. It's also really exciting and is part of the story of humans exploring the limits of their environment. We'll talk more about where humans might go next later.

Section 2: “Understanding Space” - how we are learning about our Solar System, our Galaxy and even our Universe

Understanding Space Quiz (write the name of the planet under the picture)

 <p>(photo credit: NASA / JPL)</p>	 <p>(photo credit: NASA, ESA, and A. Simon)</p>
<p>1 Answer: Mars. The 'Red Planet' has lots of iron in its soil which gives it its rusty colour.</p>	<p>2 Answer: Jupiter. The biggest planet in the Solar System, easily recognised by its Great Red Spot, a storm that is bigger than the entire Earth!</p>
 <p>(photo credit: Wikipedia Commons)</p>	 <p>(photo credit: goodfreephotos.com)</p>
<p>3 Answer: Saturn. Easily recognised from its famous ring system (although Neptune and Uranus also have rings)</p>	<p>4 Answer: Earth. Which just shows there are some weird places on our own planet! These are boiling mud springs in Yellowstone National Park, USA.</p>

Understanding Space – sending machines to find things out

If we could only understand the places that people have actually been to, then we would only really know about the Earth and the Moon. But you've already learned that we know much more than that. Some of what we know comes from looking into space from Earth; people have been doing that for hundreds of years. But we have learned a lot more by sending space probes to other planets in our Solar System, and by using other spacecraft to look even further into the Universe.

In fact, we have been doing so well at this, that there are really quite a lot of spacecraft scattered around our Solar System. We have sent spacecraft to fly past all the planets, as well as some of the other minor bodies including Pluto, a couple of asteroids and even a comet. We have actually landed spacecraft on Mercury, Venus and Mars. Space is getting quite crowded [slide showing where some of our space probes are now].

On the slide you can see that 5 of our spacecraft have actually left the solar system and are on their way to the stars. The furthest spacecraft from Earth is Voyager 1, which was launched in 1977 and is now over 21 billion kilometres from Earth! That's almost an impossible distance to imagine, but as you can see on the slide, if I try and show you where Voyager 1 and its other long-distance buddies are, I have to make the Solar System so small you can't even see the Earth any more ...

[Note: the NASA [Eyes on the Solar System](#) App allows you to explore where spacecraft are and what they are telling us]

These spacecraft have taught us a huge amount about our solar system. Learning new things is exciting on its own, but the things we are finding out are really important too. Looking at Venus, for instance, shows us just how extreme things can get if global warming runs away out of control. Visiting the giant outer planets helps understand how they formed and, because scientists believe that the way planets are arranged in the Solar System has a big effect on whether you get habitable planets like earth, also helps us think about whether other Solar Systems might be home to life like ours.

But even the amazing distance covered by Voyage 1 is tiny on the scale of the entire Universe. If we want to know more about other stars and galaxies, we need to use telescopes. The Hubble Space Telescope has been providing breathtaking pictures of our Universe since 1990, showing us things that telescope here on Earth could never manage. The middle picture on this slide is sometimes called the 'Pillars of Creation' and shows a place where new stars are being formed in the Eagle Nebula (7000 light years away). The final picture might look like a collection of stars, but they are actually all galaxies – collections of millions of stars – but so far away that even Hubble can't see the details (up to 13 billion light years – practically the edge of the Universe). Studying the universe at this sort of distance helps test our theories about how the Universe was formed and how it might continue to develop.

Section 3: "Using Space" - how space makes our modern lives possible

Using Space Quiz (circle all the things that rely on Space to work properly)

The Internet

Weather Forecasts

Mobile Phones

Understanding Climate Change

Television

Rescuing Sailors

Answer: All of them! And lots of other things as well!

Using Space – how does space help me?

Exploring space, whether in person or using space probes has taught us some amazing things, but how does space effect your daily life?

You might be surprised how many things depend on space. You might be less surprised if you look at this picture which shows all the satellites orbiting the Earth right now. All that space stuff (about 1200 of them) must be good for something, right?

The most obvious way we use space today is probably Satellite Navigation or SatNav. This works by having a hundred or so satellites orbiting the Earth which constantly send out very precise time signals. A SatNav receiver in your smartphone or other device detects these signals and uses them to work out where you are. It's quite complicated maths, but that's what your smartphone is good at!

The SatNav time signal is really important in lots of other ways. For example, the internet, and most mobile phone networks, rely on all parts of the network agreeing what time it is to an amazing level of accuracy – fractions of a second. If they don't all agree on the exact time, then bit of internet traffic can get mixed up and mobile phones start to interfere with each other.

Being in space lets us look at the earth. This is important for lots of reasons, such as looking at the weather, including tracking dangerous storms and hurricanes in real time, to help save lives. We can also look at the information we collect over longer periods of time to help monitor things like global warming, deforestation and other environmental issues.

Because the world is round, you can't see all of it from the ground. But the higher you go, the more you can see. Satellites are really high, so they can see a lot of the world. That makes them good for sending out TV signals to lots of people – some of you may have a satellite TV dish on the side of your house. It also makes them good for looking out for emergencies: ships going out of sight of land often carry an emergency radio beacon which can be triggered if the ship gets into trouble. The signal it sends out is detected by satellites and sent back to rescue coordination centres around the world to tell them to send help.

In my job in the RAF we also make use of satellites. This picture was taken in Afghanistan in 2009 and shows a satellite communications dish which I was using to link the Army and RAF headquarters there back to the UK.

The picture on the right is from a British satellite called Carbonite-2, and shows Dubai airport. You can clearly see the planes on the runway and at the departure gates. The ability to take these pictures from space helps us understand parts of the world that it can be quite hard to get to.

Section 4: The Next 'Giant Leaps' in Space – what does the future hold?

Next 'Giant Leaps' in Space Quiz (circle the right answer)

1. How fast do you have to go to get into Space?

About 10 km per second About 50 km per second About 100 km per second

Answer: About 10 km/s (actually, 11.19 km/s).

Fun Facts: This speed is known as 'escape velocity' because it is the velocity (speed) you need to 'escape' from the Earth's gravity. If it doesn't sound that fast, remember we are measuring in kilometres per second here. 11.19 km/s is over 40,000 kilometres per hour or over 25,000 miles per hour. At that speed you could travel the whole length of the UK in less than 2 minutes!

2. How high do you have to go to officially be in Space?

50 kilometres 75 kilometres 100 kilometres

Answer: 100 kilometres

Fun Facts: The Earth's atmosphere thins out as you go higher, but there isn't a well defined 'edge' to it, so for a long time there wasn't a formal definition of where space began. Today the 'Karman Line' is recognised by most nations as the edge of space at 100 km altitude. This is five times the height that aircraft fly at, and actually slightly higher than the altitude where meteors (shooting stars) start to burn up.

3. Is there a Space launch site in the UK?

Yes No, but there will be soon No, that's a crazy idea!

Answer: No, but there will be soon

Fun Facts: Space launch sites were traditionally placed as close to the equator as possible in order to use the speed of rotation of the Earth to help achieve the massive speeds necessary to get into orbit. But there are more and more applications of space where being away from the equator is an advantage – for example, getting into an orbit which flies over the poles. The UK government is planning to establish space launch sites in Cornwall and Scotland and is aiming for the first launches in just a couple of years time.

Next 'Giant Leaps' in Space – things to watch out for in the next few years

A Return to the Moon: America plans to return to the Moon by 2024 and even establish a permanent base there. We know we have the technology to get to the Moon, but living there for more than a few days means we need to find ways of getting as much of our air, food and water supplies from the Moon as we can. It is going to be a huge challenge, but also one of the most exciting things in space for years.

A Human Mission to Mars: One of the reasons for a Moon base is to use it as a stepping stone for a

crewed mission to Mars. But the American's are not the only people planning a trip to the Red Planet. Elon Musk, the owner of Tesla, is also planning to get there as part of his developing space launch business. Whoever makes it there first, it seems very likely that you will see people on Mars within the next 10 years.

Space Launches from the UK: We saw in the Quiz that the UK also plans to get into the space launch business, again, in the very near future. The UK space industry will be growing at a great pace over the next few years, so if you think space is exciting, there will be plenty of jobs for people who want to have something to do with space. Who knows, some of you may even become some of the next British astronauts!

Conclusion

- *Thanks for having me*
- *Space is really important to our daily lives*
- *And pretty exciting – especially the human spaceflight side*
- *There's a lot going to happen in the next few years which YOU might be able to get involved in*