Based on ~100 words per minute

00:00 – 00:23 = Intro/Credits. No Voice

00:24-00:52 =Apple Falling

Humanity is driven to explore, and to understand. From the easiest to the most sophisticated science experiment, or the simplest to the most ambitious engineering project, people throughout history and around the world have examined, studied, tested and considered every aspect of the world they can think of.

But the world is not enough…

00:52-01:26 =Apple Falls "off screen", Launch sequence begins

For thousands of years astronomers have looked into the cosmos, trying to determine the secrets of what they've seen.

Over time, we have built up a huge repository of information about the universe around us, but few things are as thrilling as the idea of actually leaving the Earth behind entirely and making our way into the vastness of space itself.

01:29-02:01 =Launch from afar, moving into space

For most of our history, we have only been able to observe. To reach space, humanity has had to invent and refine technology that allows us to fight the gravitational pull of the Earth.
Enormously powerful rockets, and huge amounts of fuel are required to launch us towards this Final Frontier…

02:02-02:14 =Title Sequence

02:20-03:21 =ISS (just before rapid transition)

The International Space Station is an artificial satellite that orbits the Earth more than 15 times a day at a height of approximately 400 km above the ground- this is known as Low Earth Orbit. There are many satellites with much higher orbits, but the ISS is the world's permanently-occupied outpost in space.

More than 100 metres wide, with a full crew of six, this space station was built over a number of years by the international community, and continues to grow. On board, astronauts, scientists and engineers use a number of laboratories to work on many fields of research.

03:23-04:21 =Microgravity/water globule sequence

The ISS is a *microgravity* environment: objects, and liquids, float around. So do people! The environment is very unlike anything you might experience on Earth, which can be tremendously exciting, but with its own challenges, and dangers.

Crew typically spend months at a time on board, and this affects many aspects of the astronauts' biology. Eyesight, reaction times, bone density… simply being in space changes you!

In the future, journeys to more distant locations might require astronauts to live in space for much longer periods of time: any information we learn will help to make these longer voyages safer and easier.

04:23-05:21 =Black Hole sequence

But are we really prepared for the conditions of space? Can we cope with the objects we find there?

The Earth, or even a microgravity environment might be far preferable to finding yourself near a black hole, for example; here, gravity is so strong that not even light can escape. Get too close and you would be inexorably pulled in…

There's no doubt that the exploration of the Final Frontier could be extremely hazardous. We're going to have to build on our extraordinary heritage if we want to succeed.

05:22-07:10 = "Model spacecraft" section

The first artificial satellite was launched into space in 1957: Sputnik 1, and the first human spaceflight was made by Yuri Gagarin in 1961, on board Vostok 1. Further milestones passed quickly, and today countries and organisations around the world are developing ever-more complicated and impressive methods and machines to explore space.

It is important to understand that the crew of any spacecraft are supported by a large team with expertise in many different fields. Scientists, engineers, mathematicians, doctors and many others from around the world come together and contribute to successful missions.

We also have to remember that many space missions are unmanned probes, sent to places we can't send people to yet (or return them safely…). Others, like space telescopes, don't always have to go very far, but they collect vast amounts of information about the universe around us.

The more information we have about potential targets for exploration, and those environments, the better. We can shape the spacecraft of the future by drawing on the triumphs of the past, and incorporating new scientific insights, along with new technologies, material and methods of construction.

07:11-09:02 =Flight to Moon, past Jellyfish

Of course, it is difficult to predict exactly what future spacecraft will look like. They may seem very strange to us now, perhaps even ridiculous, but the most important thing will be what they can do.

The farthest any *human* has travelled into space has been the Moon. Earth's largest natural satellite is approximately three hundred and eighty four *thousand* kilometres away, and orbit's the Earth in a little over 27 days.

The moon itself is very unlike the Earth. It has no real atmosphere, so astronauts must wear spacesuits to be able to breathe.
Gravity is different too. Stronger than the microgravity we've seen, but only about a sixth as strong as that on Earth, astronauts on the moon are able to jump very high.

A spacesuit would also be needed to protect you from the changes in temperature: the Moon is very hot in the sunlight, but extremely cold otherwise – temperatures as low as -238 degrees Celsius have been recorded!

09:03-10:55 =Moon Phase sequence, move away from Moon, fade to black.

The Moon does not shine on its own –there are no lightbulbs, fires, or anything that *creates* light for us to see- but it does reflect light shining on its surface.

From Earth, we can often see this reflected sunlight quite easily, though at different times we see that different parts of the moon are illuminated: to our eyes, we see different shapes, or *phases* of the moon.

However, if you look carefully, about half of the Moon is hidden from sight by its slow rotation. This *far side* of the Moon can only be seen by sending spacecraft beyond the orbit of the Moon.

And yet, the Moon is only our nearest celestial neighbour: not worthy of being our *Final Frontier*. We want to go much further on our voyage!

PART 2: All timings will need shuffled back or forth by a couple of seconds, but should be consistent within the section.

00:00 – 01:04 =Solar System, Planetary Orbits Highlighted

The Earth is one of eight planets in the *Solar System*. All of them orbit the Sun, and Earth is the third-closest at a distance of *one hundred and fifty million* kilometres!

From afar, planetary orbits make the Solar System look wide and flat, but it is important to know that the orbits are not perfect circles, and that the Sun is not at the exact centre of the Solar System. The gravity of everything affects everything else, so the true motion of the planets is more complicated than it seems at first.

Every planet is different, and we can learn a lot from each one. But we can't visit all of them, so let's head *away* from the Sun and further out into the Solar System.

01:05 – 02:13 = Solar Wind

As we move away from the Sun, the average temperature decreases. For astronauts, the protection of a spaceship becomes increasingly important. Our spaceship will find itself travelling in the Solar Wind, charged particles streaming from the Sun, and radiation from the Sun can lead to long-term damage to human cells.

Eventually, we may travel far enough that radio communication with Earth becomes difficult: the signals will get weaker, and take longer to travel between the spaceship and home.

We may begin to feel extremely isolated. The skills of the astronauts and the careful plans of the support teams become more and more important. If something goes wrong, would anyone be able to come and help?

02:14 – 05:14 = Mars Section

Many believe that our next destination should be the planet Mars. Visible to the naked eye on a clear night, Mars has been the subject of intense speculation throughout history, as well as some outlandish ideas about what people might find.

Right now, getting to Mars would take many months. Space missions have to aim for where there destination *will be* when they arrive, not where they are when the mission begins. Orbits of planets (including the Earth) mean that it isn't possible to launch missions whenever we feel like it – every detail is planned years ahead of time to make sure that when we finally go, we have the best possible chance of success.

Mars is a small planet, with a thin atmosphere and a reddish colour due to iron oxide on the surface. Visible icy pole caps, deserts and valleys give the impression of something much like the Earth, but is it really similar?

Even if we were to land on Mars tomorrow, we would know a great deal about the planet. Multiple robotic landers have relayed information directly from the surface, while orbiting missions have taken thousands of high resolution images. But we are talking about a whole planet, and it seems certain that great mysteries have yet to be uncovered.

We know though, that gravity on Mars is about a third of the Earth's, while the very low average temperature and atmospheric pressure would mean humans would still need spacesuits. Crucially, although liquids can exist on Mars, the water is there is frozen.

Mars is a high priority for lots of organisations around the world, with many missions to the red planet planned for years to come. For lots of people though, the one that would really count is when someone actually sets foot on another planet.

05:15 – 06:59 =Saturn (Rings)

Farther from the Sun are the Gas Giant planets. Saturn, the second largest planet in our Solar System and famed for the beautiful rings that surround it, is more than nine times further from the Sun that the Earth. As a consequence, temperatures are extremely low, the sun noticeably dimmer.

The ring particles are mainly water-ice, though with rocky material too, and while some are tiny, like grains of sand, others are bigger than your house. They reflect enough light that they can often be seen quite easily through a small telescope.

The rings themselves stretch for tens of thousands of kilometres from Saturn's equator, but are only a few tens of metres thick on average. The more carefully you look at the rings, the more complicated they seem to be: they differ in thickness, density and width, have numerous gaps and extra features.

Yet for all of the information we have collected so far, we still don't know exactly how the rings formed.

07:00 – 09:19 =Titan

With no solid surface to land on, we could not step out onto a Gas Giant. A mission to Saturn would be very different from one to Mars, and we may end up concentrating on one of the planet's many moons. One in particular, seems very exciting.

Titan is the only moon in the Solar System with a thick atmosphere. Mainly nitrogen, methane and ethane, we could not breathe there, and a temperature of around minus 180 degrees Celsius makes it completely inhospitable to human life, but past robotic missions and remote observations have revealed the existence of stable liquids on the surface, which appear to form Earth-like features such as rivers and lakes.

Unlike Earth however, these fluids are hydrocarbons such as liquid methane. Though exploring the surface of the moon may be amazing, perhaps we will focus on something a bit like a submarine to explore the seas – who knows what we might find? Some scientists believe that the environment, extreme though it may seem in comparison to what we find on Earth, may provide a suitable home for some sort of *life*.

Future missions to places where alien life is a possibility will have to be even more carefully planned. If things we're encountering are also encountering *us*, we'll have to be extra cautious, but the possibility of life beyond the Earth within the Solar System is almost impossible not to dream about…

PART 3: All timings will need shuffled back or forth by a couple of seconds, but should be consistent within the section.

00:00 – 01:26 =Solar System flyout, Kuiper Belt and Oort Cloud

By the time we pass Neptune, we are more than 30 times farther from the Sun than the Earth . Out here, it is extremely cold, and very dark…

As we travel, we pass into the Kuiper Belt region, and might see some of the dwarf planets (including Pluto!). But there is no "edge" to the solar system as such. The solar wind and the sun's gravity are important far beyond the orbits of the planets, and there may even be a region called the Oort Cloud surrounding everything that extends so far that light travelling from the Sun would take more than a year to reach its outer limits .

We know very little about about the outer Solar System, at least compared to how much about where we've visited so far. Our spaceship will be collecting as much information as possible, but we're not going to stop. The jouney continues…

01:27 – 01:56 =Galaxy (General)

The Sun might be the most important thing in the Solar System, but it is itself part of the larger *Milky Way*, our *galaxy*. Those many stars that you can see in the night sky with your own eyes all inhabit the Milky Way, and looking with even a small telescope will reveal far more. The galaxy is home to more than one hundred billion other stars, perhaps as many as four hundred billion.

01:58 – 03:26 = Galaxy (Bubbles)

Furthermore, the galaxy is home to an astonishing range of objects. Clusters of stars.. stellar nurseries where stars are born.. the remnants of supernova explosions.. planetary nebula created by gently dying stars.. the list of even broad categories is long, each worthy of extensive study (not to mention uncovering the mysteries of individual examples). Neither should we forget exotic objects like black holes.. or pulsars.. or globular clusters...

Many of these objects require careful data-gathering with specialised telescopes and other equipment. Something that can hardly be seen in the visible part of the electromagnetic spectrum may produce enough x-rays, or strong enough radio waves to be easily perceived by telescopes specifically designed to detect that sort of radiation.

03:27 – 04:36 = Star Sizes

It can be quite difficult to imagine the size of other stars. While the Sun isn't the smallest in the galaxy, it is by no means the biggest…

The largest stars have extended atmospheres, and there are uncertainties in the measured sizes of many. Stars will also change size over time, so any measurement is just a snapshot of the stars' lives.

At the same time, the *mass* of the star is extremely important in determining the evolution of the star. For example, unusual stars called *neutron stars* can be twice the mass of the Sun, yet have a radius of only around 10 kilometres.

04:38 – 05:58 = Other Stars

Peering into a dark night sky, it is possible to see thousands of stars. Look carefully, and you will notice that they have different colours, related to their temperatures. Our eyes however, are not good enough to expose all of their secrets.

Other stars reveal that the Sun is a rather ordinary star, perhaps even a little boring. Blue Giants, White Dwarfs, Red Supergiants… classifying stars is important work. At the same time, many, if not most, star systems are not dominated by a single stars. Binary systems are extremely common: some have stable orbits and don't interact with each other, while others binary systems have one star which "feeds" from the material of its partner and can lead to periods of rapid brightening called novae. We have also observed multiple-star systems, and it seems likely that there will be even more complicated arrangements we haven't witnessed yet…

05:59 - 06:21 = Pre-exoplanets reveal

One of the most exciting developments in astronomy in the last few years has been the detection of planets orbiting other stars. We call these Extrasolar planets, and you may hear them being referred to as Exoplanets, or even Alien Worlds! Almost every week we discover more, and we have useful information about thousands already…

06:22 – 07:01 = Exoplanets reveal

Astronomers have grouped extrasolar planets into different families: "hot Jupiters", "Super-Earths" and more. The evidence of these planets can also be collected in different ways: most often it is the way they affect their parent star, because the exoplanets themselves are too small to be seen directly with current telescopes.

07:02 – 08:09 = "exoplanets" surfaces.

With so many extrasolar planets and stars, the number of different environments must be staggering. There may be planets entirely covered by ocean or burning deserts, illuminated by light of multiple stars or so far from their star that they are little more than a frozen ball of rock. Others may look like things we can scarcely imagine now, and the more we learn the more possibilities we discover.

For many, the ultimate achievement would be to find an extrasolar planet like the Earth. Although this means different things to different people, lots of astronomers think that the best thing to look for is a planet with plenty of liquid water.

08:10 - 09:12 = Flying through galaxies (and bubbles)

It can be hard to imagine the distances between stars. The nearest one to us, called Proxima Centaurii, is so far away that light from it takes more than four years to reach the Earth. Others are even farther, and we don't know where we'd have to go to find a suitable place to visit.

Of course, we could consider other galaxies! Light from the *nearest* big galaxies takes *millions* of years to reach us, and like stars, they vary greatly in size, composition, mass and their population of stars. Thanks to modern telescopes we have information about millions of other galaxies, but in the visible universe there are many *billions.*

09:13 – 09:40 = Hyperspace Prep / Summation

The sheer scale of our ambitions can seem daunting. From the extreme conditions of space and the difficulties of leaving the Earth in the first place, to the prospect of visiting distant stars or braving the environments of extrasolar planets, there is no denying the challenges are immense.

09:40 – 10:09 = Jellyfish moves to sweetspot and preps for hyperspace!

Current technology means some of the most desirable targets are out of reach, while others will require us to push our skills and equipment to their limits.

But our imaginations are incredibly important. Throughout history, people have wondered about what awaits us, and the kind of spacecraft that could take us there…

10:10 – 10:40 = Hyperspace

Around the world, scientists, engineers, astronomers and many other professions are collecting information about the universe around us, and using it to push the boundaries of what is possible.

Every day produces new discoveries, new technologies, and new visions that will take us beyond where we've been before.

10:41 – 10:52 = Zoom up to star and planet. Cuts to black.

Who knows what we'll find on our Final Frontier? …

10:53 -11:53 = Credits (no voice)