You Wouldn't Want to...

BE ON APOLLO 13

Written by Ian Graham • Illustrated by David Antram

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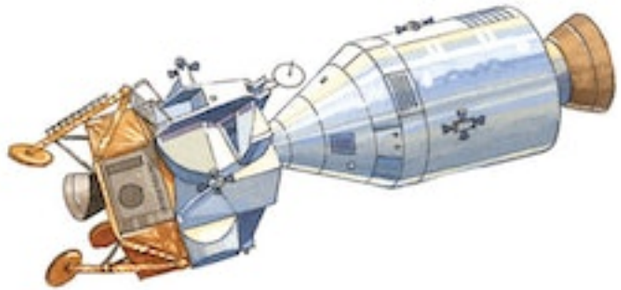

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Hatch

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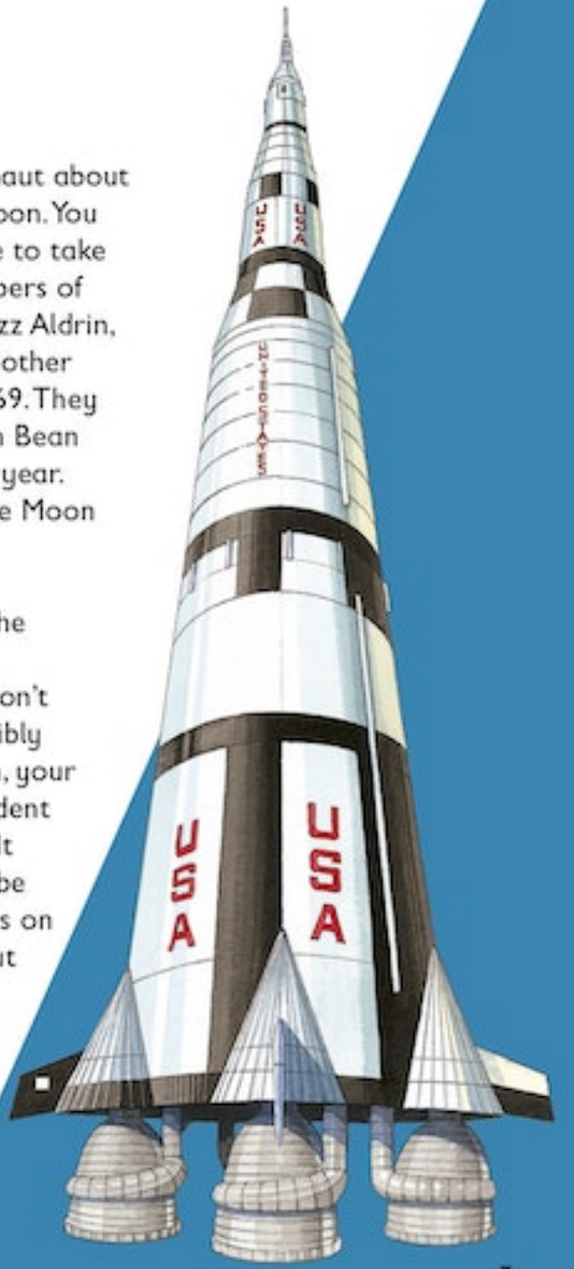
Introduction

It is April 1970. You are an American astronaut about to climb into a spacecraft and fly to the Moon. You have been training for years for the chance to take part in this mission. You watched two members of the Apollo 11 crew, Neil Armstrong and Buzz Aldrin, become the first people ever to walk on another world. They landed on the Moon in July 1969. They were followed by Charles Conrad and Alan Bean of the Apollo 12 mission in November that year. The whole world watched them explore the Moon on television.

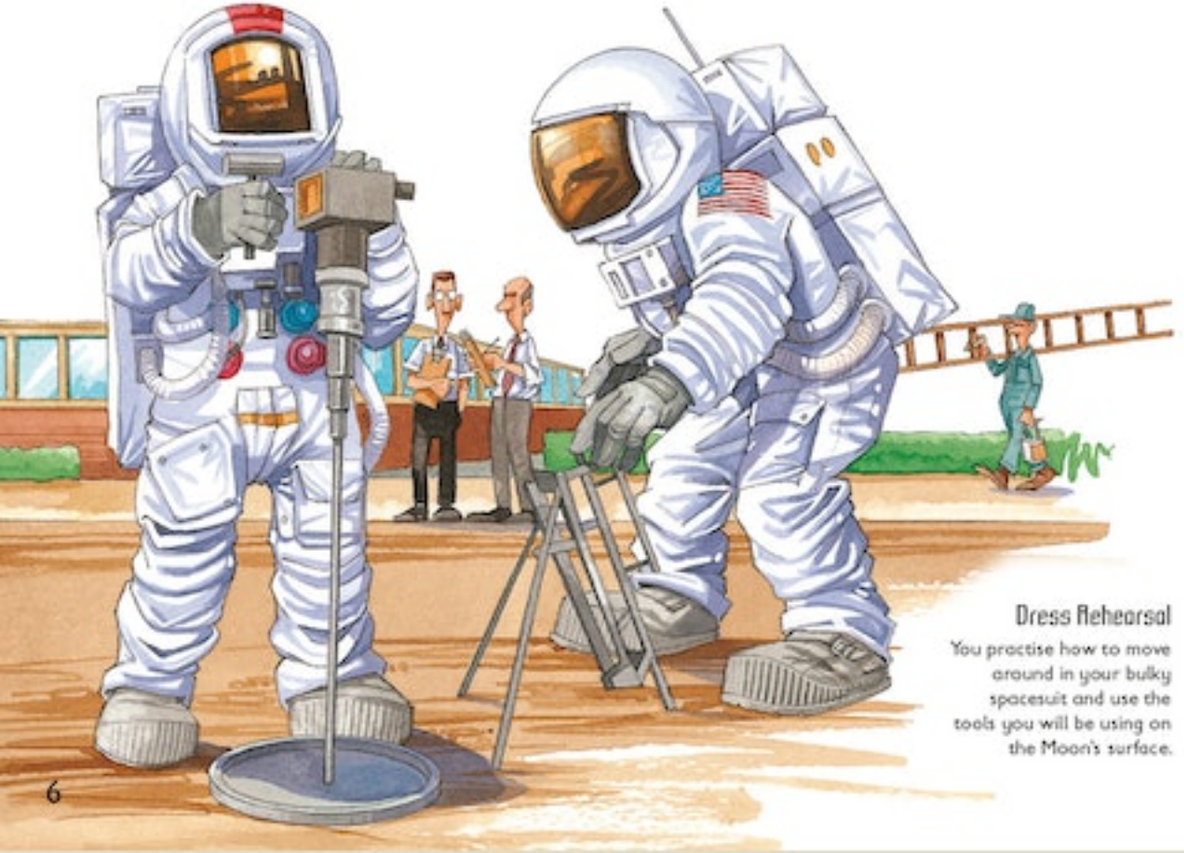
Now it is your turn. You are a member of the three-man crew of Apollo 13. Some people think that 13 is an unlucky number – you don't know it yet, but Apollo 13 will be an incredibly unlucky mission. On your way to the Moon, your spacecraft will suffer the most serious accident to happen during a Moon-landing mission. It is so serious that no one knows if you will be able to get back to Earth. Your fate depends on hundreds of engineers on Earth working out how to get you home safely.

You wouldn't want to be on Apollo 13!



Practise makes perfect

The whole crew practises everything that you will have to do during the mission. You do it over and over again until you could do it in your sleep. You train in simulators that look exactly like the real spacecraft. The mission controllers keep you on your toes by surprising you with all sorts of emergencies to see how well you deal with them. If you're going to make a mistake, it is better to do it in the simulator than on the way to the Moon. By the time launch day comes, you have to know the spacecraft inside out, be able to fly it perfectly and know what to do in any situation.



Dress Rehearsal

You practise how to move around in your bulky spacesuit and use the tools you will be using on the Moon's surface.

Handy hint

Remember to lock your spacesuit helmet firmly in place before you're lowered into the water tank for a training session!

Flying Spider

You practise flying a spider-like jet-craft designed to fly exactly like the Apollo Lunar Module.

Weightlessness

is simulated in a training aeroplane (left). So many people get airsick in this plane that it's nicknamed the 'Vomit Comet'!

On the Moon

you will weigh one sixth as much as you weigh on Earth because the Moon has less gravity. You're hung sideways so that you can see what it's like to weigh so little (right).

Underwater

You practise making spacewalks in a huge water tank (left). The uplift you get from the water provides the closest thing to weightlessness on Earth.

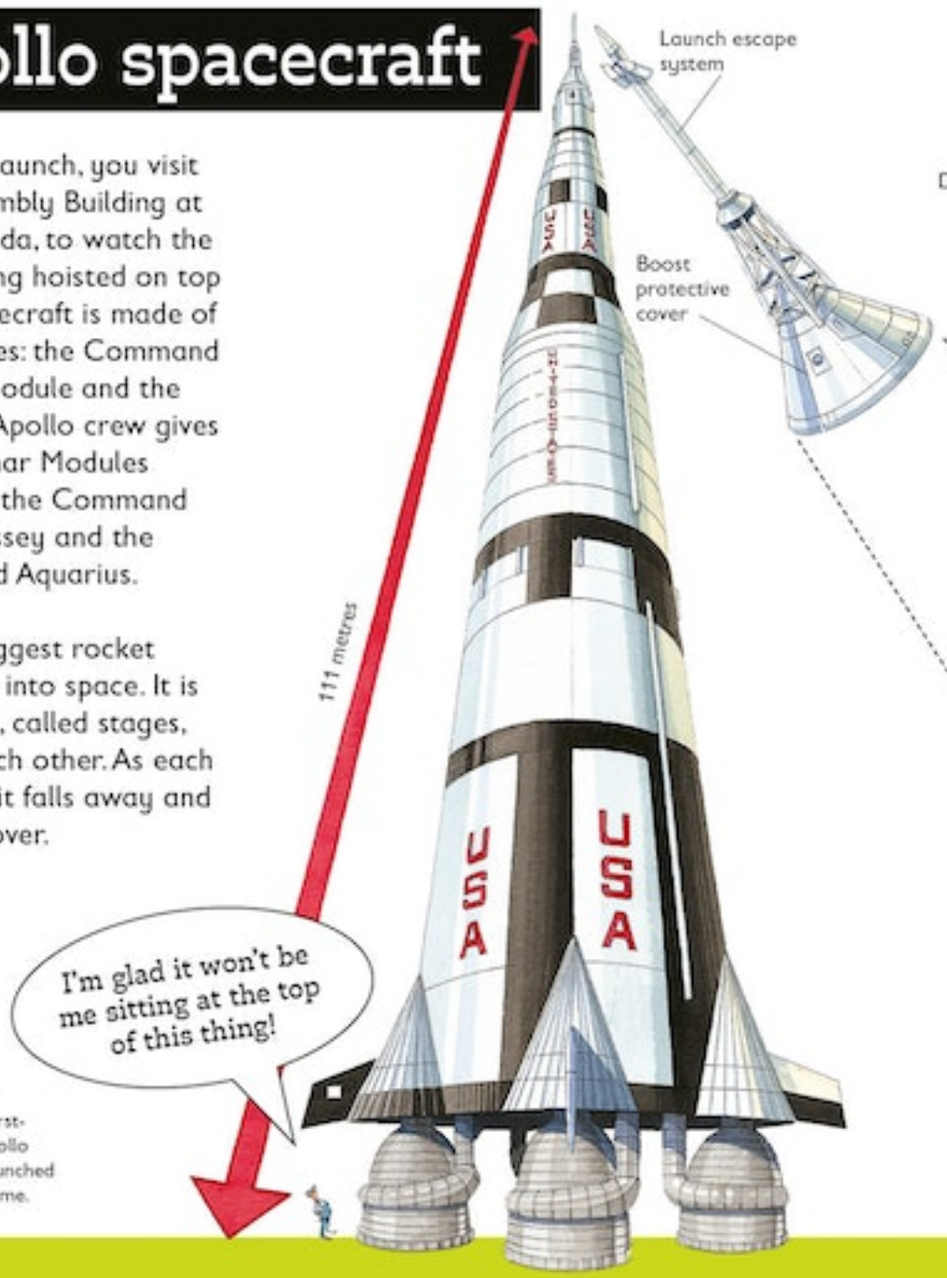
Bug Alert!

Someone the crew works with catches measles. To avoid becoming ill in space, one crew member with no immunity to it is replaced two days before launch.

The Apollo spacecraft

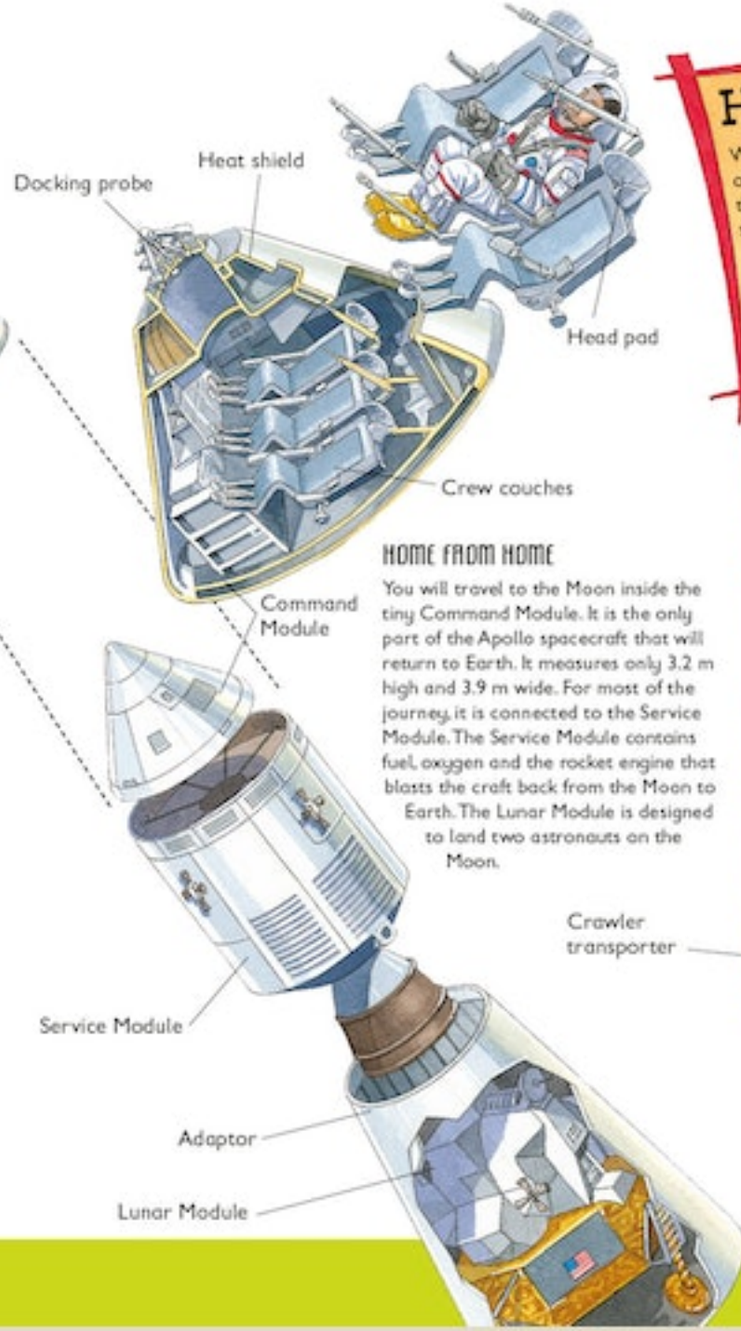
The week before the launch, you visit the giant Vehicle Assembly Building at Cape Canaveral, Florida, to watch the Apollo spacecraft being hoisted on top of its rocket. The spacecraft is made of three parts, or modules: the Command Module, the Service Module and the Lunar Module. Every Apollo crew gives its Command and Lunar Modules names. For Apollo 13, the Command Module is called Odyssey and the Lunar Module is called Aquarius.

The Saturn V is the biggest rocket ever to launch people into space. It is actually three rockets, called stages, standing on top of each other. As each stage uses up its fuel, it falls away and the next stage takes over.



GIANT LAUNCHER

The huge Saturn V rocket stands 111 metres from the base of its first-stage engines to the tip of the Apollo spacecraft at the top. It will be launched 13 times and is successful every time.

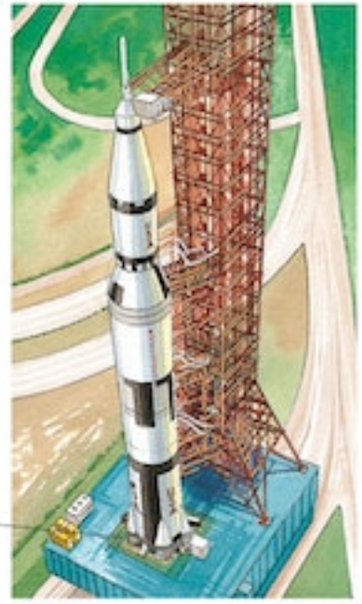


HOME FROM HOME

You will travel to the Moon inside the tiny Command Module. It is the only part of the Apollo spacecraft that will return to Earth. It measures only 3.2 m high and 3.9 m wide. For most of the journey it is connected to the Service Module. The Service Module contains fuel, oxygen and the rocket engine that blasts the craft back from the Moon to Earth. The Lunar Module is designed to land two astronauts on the Moon.

Handy hint

Watch out! Don't ever get in the way of the crawler transporter when it is on the move. This massive vehicle doesn't stop for anyone!



LAUNCH PAD

The rocket and spacecraft sitting on their mobile launch platform weighs 4,800 tonnes. This is slowly carried out to the launch pad by the world's biggest transport vehicle.

Launch day

WAKEY, WAKEY!

You are called precisely four hours and 17 minutes before launch.

SAY 99

The flight doctor gives you a final once-over four hours and two minutes before launch to make sure you are in top condition.

BREAKFAST

At 'eggs-actly' three hours and 32 minutes before launch, you have breakfast – steak, eggs, orange juice, coffee and toast – and then put on your spacesuit.

SUITING UP

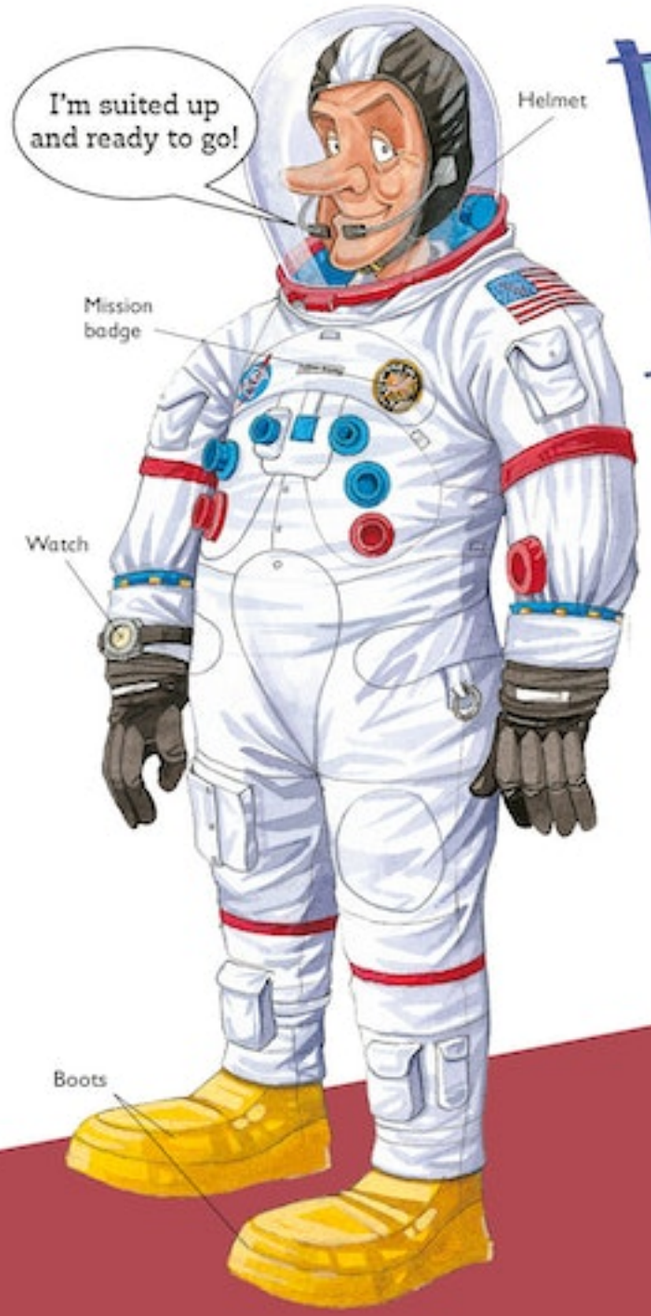
The various parts of the spacesuit are put on in order. Electrodes (1) are glued to your chest to monitor your heartbeat. Underwear – a pair of 'long johns' (2) – is the first layer next to the skin. Next, you pull on the spacesuit legs, push your head through the neck ring and pull on the body and arms (3).

Countdown to takeoff

Launch day has arrived. It is 11th April 1970. Your 400,000-kilometre journey to the Moon begins a few hours from now with a trip into orbit around the Earth. While you and the rest of the crew go through your preparations for takeoff, a team of engineers gets the spacecraft and its mighty rocket ready for you. You can't waste any time. Everything, from filling the rocket's fuel tanks to having your breakfast, has its own time slot in the carefully planned countdown. It's too late to change your mind now!

SNOOPY CAP

This soft cap (4) contains earpieces and a microphone for radio communications. A clear 'fishbowl' helmet (5) locks onto the top of the suit and gloves lock onto metal rings at the ends of the sleeves (6).



Handy hint

If you need to scratch your nose or sneeze, do it BEFORE your helmet is fitted! You can't take your helmet off again until you're in orbit.

ALL ABOARD

Precisely three hours and seven minutes before launch you board the crew transfer van. You arrive at launch pad 39A 12 minutes later.

GOING UP

You take a lift to the top of the launch tower, walk across the access arm, into the white room next to the Command Module. The team is waiting for you.

TAKE A SEAT

You board the spacecraft 2 hours and 40 minutes before launch. Take care not to snag your spacesuit as you slide through the hatch. Each one costs US$1.5 million!

We have . . .

When the countdown reaches zero, you start a 12-minute rollercoaster ride through Earth's atmosphere to space. As the rocket leaves the launch pad, the time on the clock at Mission Control in Houston, Texas, is 13.13! Pictures of the soaring rocket and its flight path appear on a big display screen at Mission Control.

RRRROARRR!!!!

Handy hint

Make sure you are strapped tightly into your seat. If you aren't, you'll bounce around the Command Module like a cork in a bottle when the rocket blasts off!

The 'T' Timeline

T minus 3 minutes, 7 seconds
The Saturn V rocket is given the firing command that starts its automatic launch sequence. Computers start its fuel pumps.

T minus 8.9 seconds
The first-stage engines fire. The rocket is held down on the launch pad until all five engines are running.

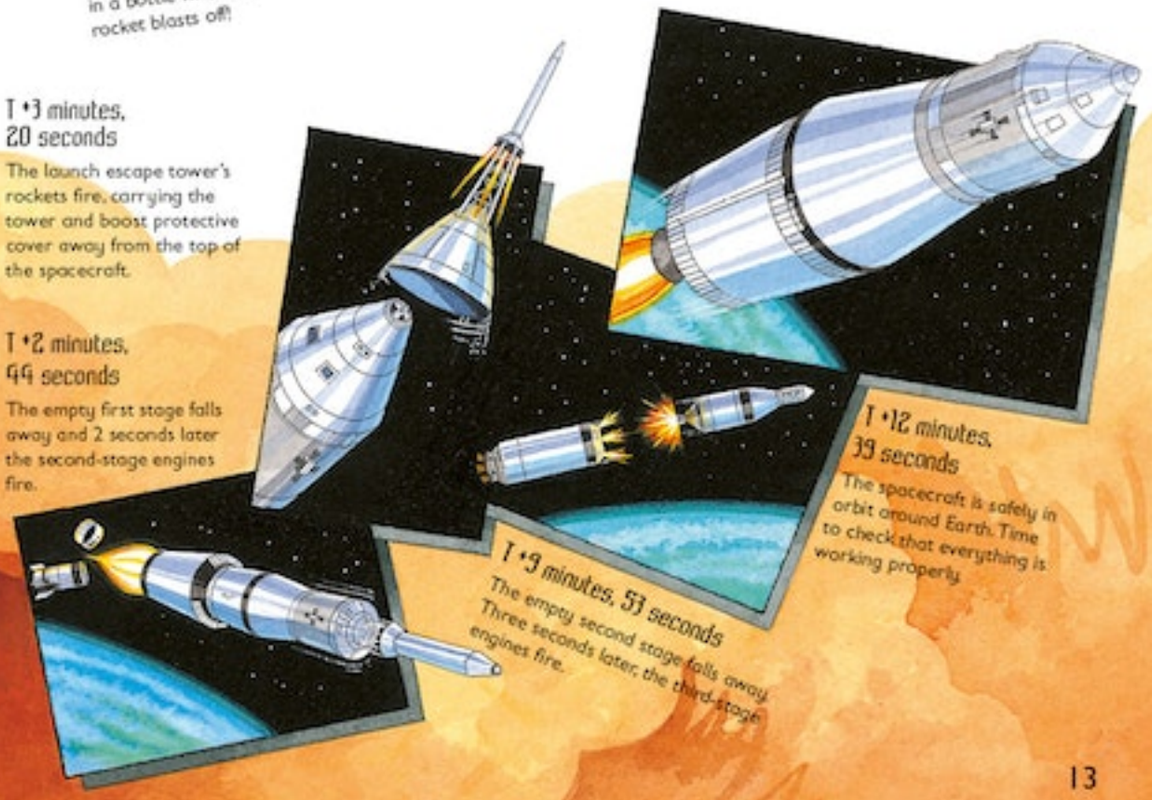
Zero
Apollo 13 and the 3,000-tonne Saturn V launch rocket gently lift off the launch pad.

T +3 minutes, 20 seconds
The launch escape tower's rockets fire, carrying the tower and boost protective cover away from the top of the spacecraft.

T +2 minutes, 44 seconds
The empty first stage falls away and 2 seconds later the second-stage engines fire.

. . . LIFT OFF!

Apollo 13's bad luck first strikes when one of the rocket engines shuts down two minutes early. For a few moments, you don't know if Apollo 13 will make it into space. The remaining engines fire for longer to make up for the fault. Engineers at Mission Control check that there is enough fuel left to send the spacecraft to the Moon.



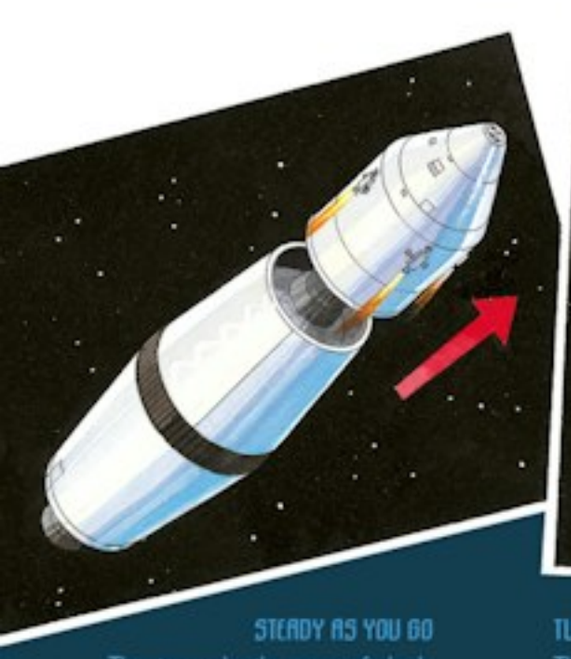
T +9 minutes, 53 seconds
The empty second stage falls away. Three seconds later, the third-stage engines fire.

T +12 minutes, 39 seconds
The spacecraft is safely in orbit around Earth. Time to check that everything is working properly.

Goodbye Earth

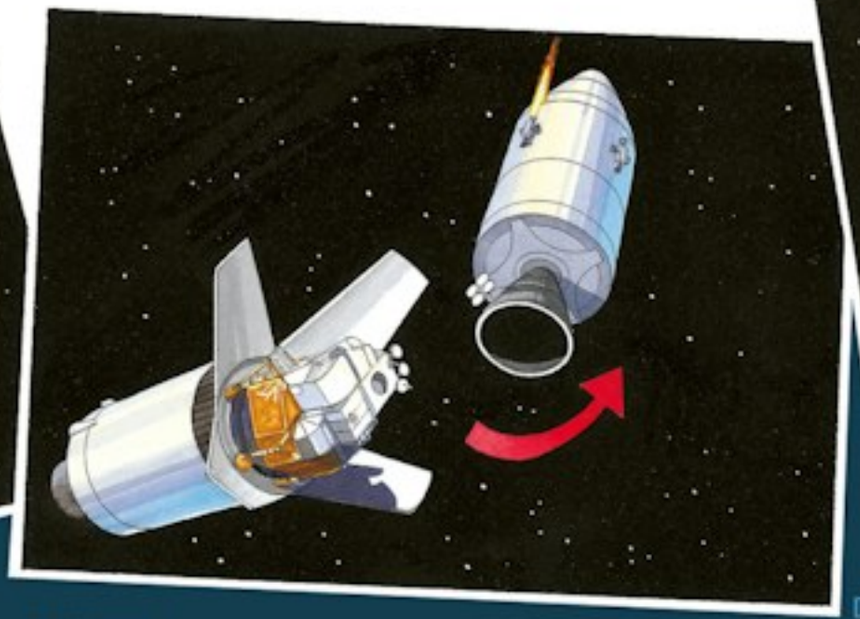
The spacecraft checks out fine, so you get the go-ahead to fire the third-stage engine and head for the Moon. The engine boosts your speed from 28,000 kilometres per hour (kph) to the 40,000 kph needed to break away from Earth's gravity. Once you are safely on your way to the Moon, there is a very important job to do.

The Lunar Module is packed away inside the top of the rocket, underneath the Command and Service Modules (CSM). The CSM has to be separated from the rocket and turned around so that it can pull the Lunar Module out. This delicate manoeuvre requires pinpoint flying. Nothing less will do.



STEADY AS YOU GO

Thrusters nudge the spacecraft slowly forwards and away from the end of Saturn V's third stage.



TURNAROUND

The thrusters are fired again to turn the spacecraft around. The end of the rocket opens up like a giant flower, revealing the Lunar Module

STEERING

You steer the spacecraft by using hand controllers to fire rocket thrusters on the Service Module.

If you suffer from space sickness, grab a bag fast. Remember, during weightlessness EVERYTHING floats around the spacecraft – yuck!

DOCKING

The CSM eases forwards and docks with the Lunar Module (above). A probe on top of it fits into a hole on top of the Lunar Module and the two craft lock together.

EASY DOES IT

The CSM slowly backs up and pulls the Lunar Module out of the end of the rocket. It all goes perfectly. You are on your way.

Living in a tin can

Being an Apollo astronaut sometimes feels like living inside a tiny tin can. You have to get along with two other people in that small space for more than a week. You have to get used to noise all the time too. The spacecraft is never completely silent. There is the hum of air pumps, voices on the radio and the sounds of other crew-members moving about. The temperature is kept at a steady 22°C, so once you're in orbit, you can take off the bulky spacesuit you wore for the launch and put on a more comfortable flight suit. In orbit you experience weightlessness and can just float around inside the spacecraft.

Handy hint

There is no 'up' or 'down' in space. You can work just as easily standing on your head as with your feet on the floor.

SPACE FOOD

You wish you could eat 'normal' food. Most space food is dried to save weight in the spacecraft (left). You add water to make it edible.

GOING TO THE TOILET

Three astronauts produce a lot of urine during a mission. To save weight, it is dumped overboard (right).

THE BARBECUE ROLL

The spacecraft spins constantly, very slowly, so that it is heated evenly by the Sun (left).

TV STAR

You present television reports, or telecasts, from the spacecraft to show viewers how the flight is going (right).

Houston, we've had a problem

On 13th April, Apollo 13 is 329,000 km away from Earth. Each day the Moon looks bigger through the Command Module windows. Mission Control asks you to turn on fans inside the Service Module's oxygen tanks. As soon as the switch is hit, you hear a loud bang. You watch your instruments in horror. The spacecraft seems to be losing oxygen and electrical power. You struggle to understand what has happened. Mission controllers on Earth can't believe what they see on their computer screens.

Disaster strikes

1. THE JOLT

You hear a bang and the spacecraft shakes violently. You think it might have been hit by a piece of space rock.

2. ALARMS

go off in the spacecraft and at Mission Control. You watch your instruments in disbelief.

3. WHAT'S HAPPENING?

Mission controllers think their computers have gone crazy. Their screens don't seem to make sense.

4. GAS ESCAPE

You look through a window and see something spraying out into space. It must be oxygen!

5. LOSING POWER

Your instruments show that the Command Module's fuel cells are losing power fast.

6. MOVE OUT!

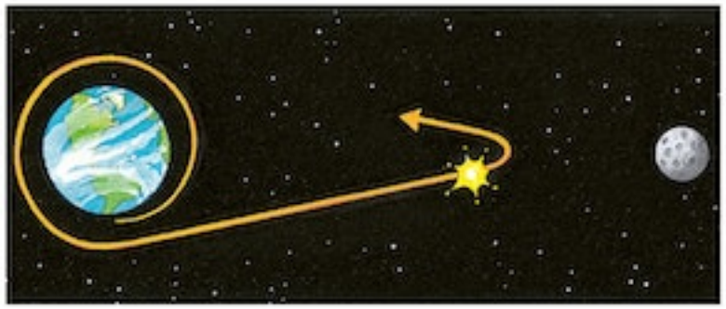
You quickly power down the Command Module and move into the Lunar Module so that you can use its air and electricity.

...WHAT HAPPENED?

Later, it is discovered that an electrical fault blew up an oxygen tank and damaged equipment in the Service Module.

Failure is not an option

At Mission Control, the flight director tells everyone to find a way to get the crew home. He shouts, 'Failure is not an option!' Ground controllers and engineers immediately start discussing what to do. Some of them want to turn the spacecraft around and bring it straight back to Earth. Others want to let the spacecraft keep going and use the Moon's gravity to swing it round and back to Earth. This option would take longer. The long way would be less risky, but no one knows if the spacecraft's oxygen and electricity will last long enough. You keep calling Mission Control to ask for their decision, but they're still working out what to do for the best.

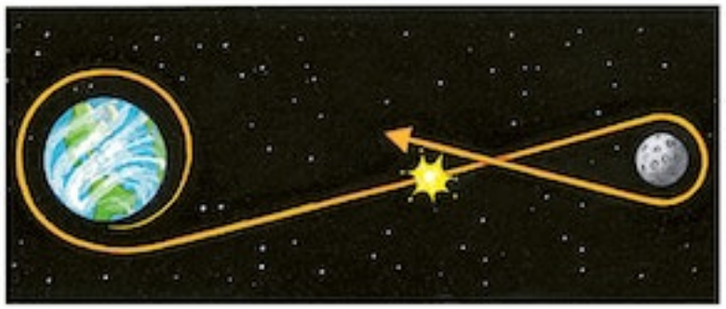


Option one

The spacecraft does a U-turn and comes straight home. It gets you home fast, but you would have to fire the Service Module engine. It might be damaged, it might not work and it might explode.

Option two

Mission controllers decide it's safer to carry on to the Moon and swing behind it. You can use the Lunar Module engine to stay on course, but it wasn't designed for this. Will this plan work?



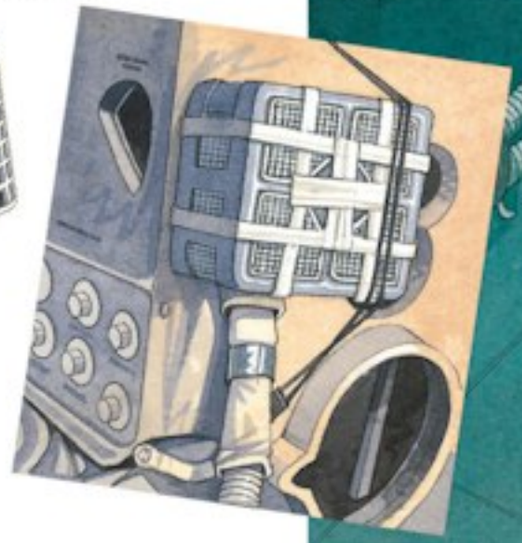
Cold, wet and stuffy

Keeping warm is not as important as getting home alive, so the spacecraft heaters are switched off to save electricity. The temperature falls to just above freezing. Moisture from your breath condenses on the cold instrument panels, walls and windows. The whole spacecraft is wet. It is dark too, because most of the lights are switched off. It gets very stuffy – the Lunar Module was designed for two astronauts, not three, so it can't purify the air fast enough. The breathed-out carbon dioxide in the air rises to a dangerous level. If it continues to rise, you will lose consciousness! You have to do something about it.

A bit of do-it-yourself

The Command Module

has air purifier canisters that could freshen the air, but they are square. The fittings in the Lunar Module are round. You make them fit by using pieces of hose, sticky tape, plastic bags and rubber bands (right). It works! The amount of carbon dioxide in the air starts falling.



A wee problem!

The crippled spacecraft is so hard to control that you have to stop dumping urine overboard. When it sprays out into space it pushes the spacecraft off course. So you have to save it all in plastic bags and store them inside the spacecraft!

Lost mission

If everything had gone as planned, Apollo 13 would have landed on part of the Moon called Fra Mauro. Apollo 11 and 12 landed in the Sea of Tranquillity and the Ocean of Storms. The ground there was flat because lava had flowed over it. Scientists wanted samples of older rocks from the hills and mountains that hadn't been covered by lava, but these places are more dangerous to land. The earlier missions proved that astronauts could fly the Lunar Module manually and choose a safe landing spot. It was decided that Aquarius from Apollo 13 would land in the Fra Mauro hills.

SPACESUIT

The spacesuit you would have worn on the Moon (right) has extra-tough gloves, boots and a visor over the helmet to keep your head cool. You would also have worn a backpack with oxygen and a radio.

If nothing had gone wrong...

MOON ROCKS

You would have collected lots of Moon rocks and brought them back to Earth.

HEAT FLOW

You would have drilled holes in the Moon's surface to test how heat flows through it.

SOLAR WIND

You would have collected samples of the solar wind – particles that stream out of the Sun and hit the Moon.

PHOTOGRAPHY

You would have taken thousands of close-up photographs of dust, rocks and craters on the Moon's surface.

MOONQUAKES

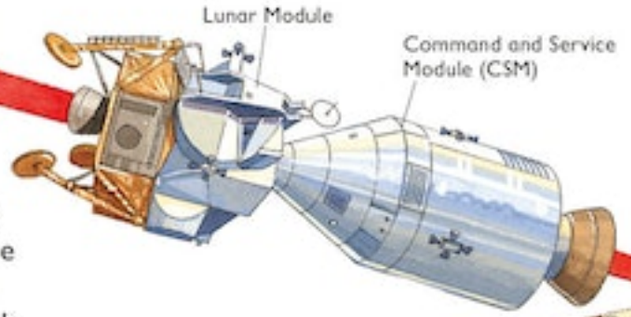
You were planning to put instruments on the Moon's surface to detect the vibrations of moonquakes.

LONE ORBITER

While two astronauts explored the surface, the third would orbit the Moon alone in the Command Module.

Going home

You receive new instructions from Mission Control. You are to fire the Lunar Module's descent stage engine to change course. If it works it will send you around the Moon and back to Earth. This engine was not designed to be used like this. It is the engine that would have slowed the Lunar Module down as it approached the Moon's surface. The engine has to be fired before you reach the Moon and again just after you reappear from behind it. While you are behind the Moon, you are out of contact with Mission Control. If something goes wrong, no one can help you.



Handy hint

Remember to close the Command Module hatch before you undock the Lunar Module and cast it adrift. Otherwise you'll be sucked out into space!

NERVOUS WAIT

As the spacecraft disappears behind the Moon, everyone in Mission Control can only wait and hope that the burn (the firing of the engine) has gone well.

WHAT A VIEW!

You gaze out of the Lunar Module's windows at the Moon as you fly over your landing site at Fra Mauro. Then Earth slips out of sight as you fly behind the Moon.

BURN 1

The Lunar Module engine fires perfectly for 35 seconds, speeding you on your way behind the Moon.

FIRST SIGHT

When the Service Module is finally cast adrift, you gasp as you catch your first sight of the damage (left). The explosion has blown out one whole side, from top to bottom.

BURN 2

You fire the Lunar Module engine again for four minutes to speed up your return flight to Earth (above).

GOODBYE LUNAR MODULE

You power up the damp, cold and dark Command Module and prepare for your return to Earth. You cast the Lunar Module adrift (right) and say goodbye to the craft that acted as your lifeboat.

Down to Earth

You are nearly home but you still face the most dangerous part of the mission – re-entering the Earth's atmosphere. It is very important to keep the spacecraft on course so that it hits the atmosphere at the right angle. If it comes in at the wrong angle it will either burn up or bounce off.

The heat shield glows red hot. It is all that stands between you and the extreme heat outside. No one knows if it was damaged by the explosion. The air around the spacecraft gets so hot that radio waves can't get through. You can't talk to Mission Control and they can't hear you. They do not know if you are alive or dead.

TOO SHALLOW.

A spacecraft hitting Earth's atmosphere at too shallow an angle would bounce off it like a stone skipping across water.

TOO STEEP

If the Command Module dives into the atmosphere at too steep an angle, it will get too hot and burn up.

CHUTES OPEN.

The Command Module falls through the clouds and floats down under three huge parachutes.

Handy hint

When you step out onto the deck of the recovery ship don't get too close to anyone – remember, you haven't had a bath for a whole week!

WELCOME HOME

You step out of the helicopter onto the deck of the recovery ship and wave to the crew and cameras.

'13 CALLING'

Cheering breaks out at Mission Control as the radio crackles into life and you report in (above).

SPLASHDOWN

The module hits the ocean with a mighty splash (below left). You're safely back on Earth.

DIVERS KNOCK

on the spacecraft hatch (below) and help you out to a waiting helicopter.

Glossary

Boost protective cover The cover that protected the Apollo Command Module during launch.

Burn A short firing of a rocket engine to change a spacecraft's course.

Canisters A container, usually made of metal.

Cape Canaveral A place in Florida, USA, where the John F. Kennedy Space Center is located. Many space flights are launched from there.

Carbon dioxide A gas that is breathed out by people.

Command Module The cone-shaped part of an Apollo spacecraft, where crew lived.

Crawler transporter The giant vehicle that moved Saturn V rockets from their assembly building to the launch pad.

CSM The Command and Service Module, a spacecraft made from the Command Module and Service Module, linked together.

Fuel cell A device that uses oxygen and hydrogen gases to make electricity and water.

Gravity The force that pulls everything towards a large object such as a planet or moon.

Hatch A doorway in a spacecraft.

Heat shield The part of a spacecraft that protects the rest of the craft from the heat of re-entry.

Launch escape tower A rocket designed to fly the Command Module away to safety in an emergency during launch.

Lava Molten rock that flows out onto the surface of a planet or moon.

Lunar Module The part of an Apollo spacecraft designed to land on the Moon.

Manually Done by hand instead of being done automatically by machines.

Mission Control The building where the space flights are monitored and managed.

Orbit To travel in a circle around a planet or moon.

Oxygen A gas which humans need to breathe. It was also used to make water and electricity, within the Apollo spacecraft.

Particle An extremely small piece or speck of something.

Recovery ship A ship sent to where a spacecraft is expected to land to pick up the crew.

Re-entry Coming back into the Earth's atmosphere from space.

Service Module The part of an Apollo spacecraft that supplied the Command Module with oxygen, water, electricity and rocket power.

Simulator A machine made to look like a vehicle, such as a spacecraft, used to train pilots.

Stage Part of a larger rocket with its own engine or engines, that falls away when its fuel is used up.

Thruster A small rocket engine used to adjust the position of a spacecraft while in space.

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