



# ZOOM TO THE MOON

## Help Zoom get home to the Moon!

Zoom's a little alien who's got lost and ended up on Earth. He needs your help to build a spaceship to get him home.



**Can you help design a Moonpod for Zoom to get him back on track?**

Moonpods, like all space craft, are quite complicated and there's lots of choices to be made. So to help Zoom build the perfect Moonpod, explore this comic and find more about some of the things designers and engineers have to think about.

**3, 2, 1...**  
**READY FOR**  
**LIFT OFF!**



# MATERIALS

Space craft, whether for humans or aliens, are made of a huge range of different materials. Engineers have to be careful in choosing exactly the right material for the job, and when you think about it there's a lot of jobs to be done! From the tip of the nose cone to the bottom of the thrusters, there's no room for getting it wrong in the extreme temperatures and conditions of space...

What materials will you use for Zoom's Moonpod?

## ALUMINIUM

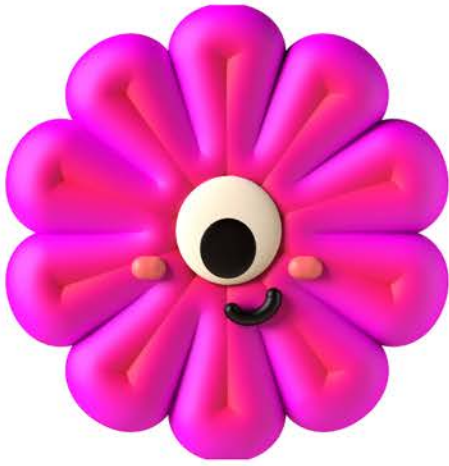
Aluminium is a very light metal, making it great for space rockets as it reduces weight and helps the fuel last longer. It also doesn't corrode easily, which is very important in harsh space environments. It's also fairly easy to find here on Earth and it's cheaper than quite a lot of other materials.

Hmm!  
Sounds good but aluminium is just not as tough as other materials. This means it can't be used where strength is important

## TITANIUM

Titanium is very light, tough and strong, making it a valuable material for space rockets. It doesn't corrode easily and can stay strong in the extreme temperatures you experience during space travel.

Why did the cow go into space?  
To see the moooooooon!



## AEROSPACE ENGINEER

*Designing, developing, and testing spacecraft, rockets, and related systems for space exploration.*

Carbon fibre's a useful material but it can be more easily damaged than metals. Recycling it is also challenging so it's not great for the environment!



## PROPULSION ENGINEER

*Designing and optimising rocket engines and propulsion systems for efficient and reliable space travel.*

Just like you, people working on space missions have to weigh up the pros and cons to build the best possible, safest and most efficient space crafts and missions.

And did you know there are thousands of people who work in space exploration, in a variety of different jobs - they're scattered throughout this pack - perhaps in the future you'll be part of the team!

## CARBON FIBRE

Carbon fibre is a popular choice for vehicle chassis and body panels - whether a humble hatchback or a Formula 1 car, because it's both light and tough - very tough! Being light is important as it means less fuel is needed to get a spacecraft off the ground.

The tallest space rocket ever built was Space X's Starship. Its Super Heavy Booster was a whopping 120 metres - that's nearly as tall as the London Eye!

**WAIT!**

Have you thought about which material you might use for Zoom's Moonpod?



# FUEL

You can't lift off without fuel and you'll need quite a bit of fuel to propel your Moonpod into orbit and all the way to the moon. And as there aren't any planetary petrol stations – well, not yet... you'll need to take all the fuel needed with you.

## LIQUID HYDROGEN

Liquid hydrogen offers excellent thrust and propulsion - that's the push that carries the rocket forward. There's lots of hydrogen available, and it produces clean exhaust, consisting mainly of water vapour, making it environmentally friendly.



Great stuff! But liquid hydrogen takes up a lot of space and that means large heavy fuel tanks will be needed - which means more fuel to get off the ground...



## HYDRAZINE

You've probably not heard of this fuel before - Hydrazine is very easy to ignite when it reacts with other chemicals and it's compact to store making it a great choice for space flights.



## SYSTEMS ENGINEER

*Integrating various components and subsystems to ensure the overall functionality and performance of space missions.*

# BIOFUELS

Created from renewable sources like plants and algae, biofuels offer the potential for a more sustainable and environmentally friendly alternative to traditional rocket fuels. A great benefit is that we already have the means to produce them.

It's still early days for biofuels for space rockets and making the large quantities needed might be tricky.

What do you call an alien with three eyes?  
An aliiien!

## DID YOU KNOW?

The engines on the Saturn V launch vehicle - the rocket that took men to the moon between 1967 and 1973, could carry a payload weighing of up to 130 tons into orbit around the Earth, according to NASA. That's about the weight of 10 school buses or an adult blue whale!



## GUIDANCE, NAVIGATION, AND CONTROL ENGINEER

*Developing systems and algorithms for spacecraft guidance, navigation, and control during space missions.*



## STRUCTURAL ENGINEER

*Designing and analysing the structures of spacecraft and launch vehicles to ensure they can withstand the extreme conditions of space travel.*

**WAIT!**

Have you thought about which fuel you might use for Zoom's Moonpod?





# RADIATION PROTECTION

Just like we wear sunscreen to protect ourselves from harmful sun rays, space rockets need special protection from the sun's radiation and rays from distant galaxies - without the protection of our ozone layer and atmosphere, radiation could cause serious damage to craft and harm to humans - or aliens on board.

## POLYETHYLENE

Polyethylene is a lightweight, non-toxic and quite a cheap material. It's pretty good shielding against galactic cosmic rays and solar particle events. It has a high hydrogen content - and hydrogen atoms are really good at absorbing and dispersing radiation.

Amazing! But polyethylene isn't as effective against high-energy radiation as metals. Also, polyethylene can wear out the more exposure it has to harmful rays...



## THERMAL ENGINEER

*Managing and controlling the heat generated by spacecraft systems to ensure optimal performance and safety.*

Another cosmic career for the collection!

There are three types of radiation and each can be stopped...

- 1 Alpha rays by a piece of paper
- 2 Delta rays by a sheet of metal
- 3 Gamma rays can only be stopped by at least a foot of dense materials such as lead...





# LEAD

Lead is a dense and very effective radiation shielding material, offering excellent protection against a wide range of radiation types, including gamma rays and X-rays. It's widely available and has a long history of use in radiation shielding applications.



There's two major drawbacks with using lead - because it's so dense and heavy, it would make launches more expensive. It's also toxic - that means it's a poisonous substance



## POWER SYSTEMS ENGINEER

*Designing and implementing electrical power systems, including solar arrays and batteries, for spacecraft.*

**Do you know what happened to the astronaut who needed the toilet?**

He went on a LOO-nar mission!



Now THAT'S radioactive!

## WEE & POO

No, it's not a joke! Radiation shielding is all about creating barriers and scientists are investigating ways to create barriers within the space craft that use waste from astronauts such as wee and poo, as well as water, and even food supplies to shield against radiation.

What about the smell?! Trials have shown that these water walls just aren't as effective as traditional methods - but scientists are continuing to experiment...



**WAIT!**

Have you thought about which protection you might use for Zoom's Moonpod?



# COMMUNICATION

01000000 01000000

**Earth to Zoom!** Astronauts need to communicate to mission control, and space craft need to be able to share data with computers on Earth. Your mobile phone probably won't get a signal in space, so you'll need to think about a communication system.

## RADIO

Radio waves can penetrate the Earth's atmosphere, meaning it's easy for people to communicate directly between spacecraft and ground stations. And radio systems are pretty simple, reliable and compact, and don't need as much power as other communication systems.



**COMMUNICATIONS ENGINEER**

*Developing communication systems and protocols for reliable data transmission between spacecraft and Earth.*

Got the message loud and clear! But radio isn't always clear - radio signals can be affected by interference, noise and the atmospheric conditions, leading to drops in the signal

## SATELLITE

Satellites in orbit can relay signals between spacecraft and ground stations, and can transmit large volumes of data such as images and scientific measurements. Satellite communication can provide continuous coverage even in remote or inaccessible areas of the Earth.



There are over 10,000 satellites currently orbiting earth - amazingly over the last thirty years there has only been one collision although many satellites are damaged by space debris.



## ROBOTICS ENGINEER

*Designing and developing robotic systems for exploration, maintenance, and assembly tasks in space.*



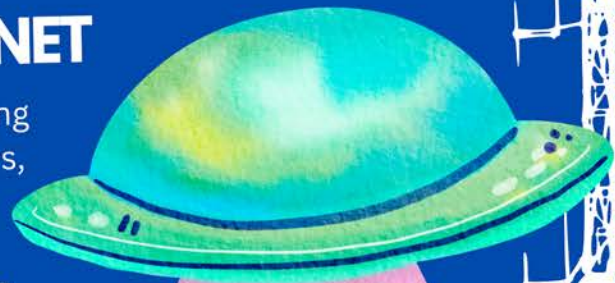
## MISSION PLANNER

*Coordinating and planning space missions, including trajectory optimisation, payload allocation, and mission objectives.*

## INTERPLANETARY INTERNET

This is a concept still in development, aiming to use “stepping stone” satellites and relays, to enable high-speed and reliable data transmission between spacecraft, rovers, orbiters and Earth-based systems. It will be able to exchange large amounts of data across vast distances within the solar system with fewer losses.

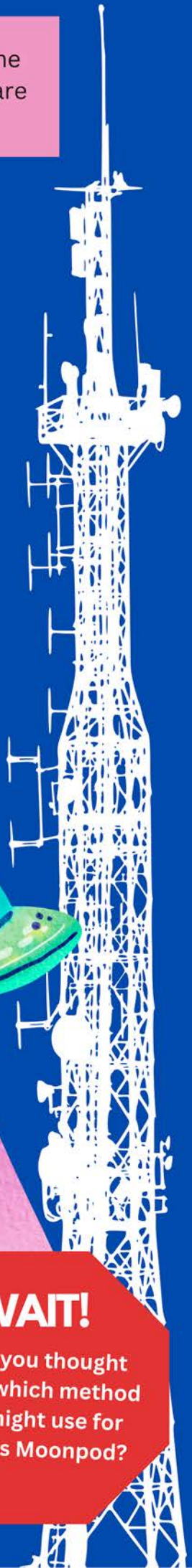
But it'll be a challenge to set up because the time delay for signals to travel between planets can range from minutes to hours and this sort of deep space communication also needs a lot of power!



**What did the alien use to keep his trousers up?  
An asteroid belt!**

**WAIT!**

**Have you thought about which method you might use for Zoom's Moonpod?**



# STAYING HEALTHY

Life on board a space craft is very different to life on Earth - and we want Zoom to be comfortable on his way home. So what might help keep Zoom safe and healthy in his Moonpod?



## INSTRUMENTATION ENGINEER

*Designing and developing scientific instruments and sensors for data collection and analysis during space missions.*



## SOFTWARE ENGINEER

*Developing and maintaining software systems for spacecraft control, data processing, and mission operations.*

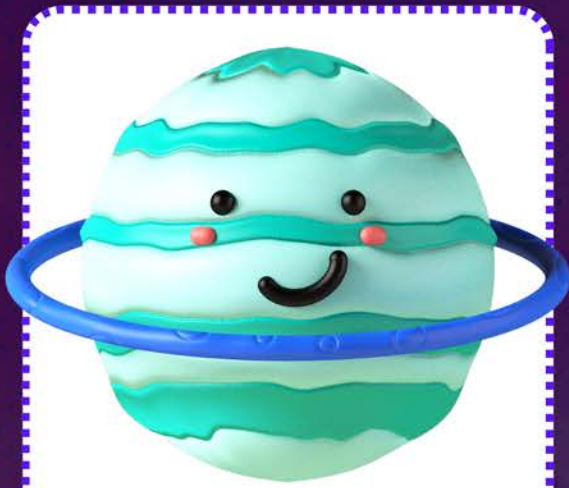
## EXERCISE

It looks like fun being weightless in space but it's actually not great for the body. Prolonged exposure to microgravity leads to muscle and bone loss, the weakening of the heart muscles and changes in the way the body retains water.

We'll have to make sure we have a fitness routine like they do on the International Space Station - with aerobic exercises and resistance training. Exercise is also good for mental health - something that can be put under pressure on space missions which can be both stressful and boring at times...

**Where do astronauts keep their snacks?**  
In their LAUNCH box!





## ENVIRONMENTAL ENGINEER

*Assessing and managing the environmental impacts of space exploration activities and ensuring compliance with regulations.*

I snuck a sandwich aboard a spacecraft!



On 23 March 1965, a corned beef sandwich was smuggled into space aboard NASA's Gemini 3 in the spacesuit pocket of astronaut John Young.

## HUMAN WASTE

Human waste - that's wee and poo, and not forgetting everyday wastewater, has to go somewhere on a space mission and this can be a challenge when there's limited space.



Again we can learn from the ISS, solid waste is compacted, dehydrated and stored for disposal on returning spacecraft. Urine and wastewater are recycled for drinking and washing. We'll need to make sure systems run smoothly especially on long missions where there may be a large amount of waste to store, and where astronauts will need lots of clean drinking water to stay healthy



**WAIT!**

Have you thought about how Zoom might stay healthy in space?

## FOOD

Long-duration missions require careful planning to ensure an adequate supply of food that is healthy - but also that tastes good! Food must also be lightweight, compact, and have a long shelf life.

We're used to seeing vacuum sealed packets of food for astronauts but packets can get boring, so it would be good to include astronaut's favourite foods and snacks too. Some really cool new technology means that plants and even cultured meat could be grown on board, reducing the amount of food that needs to be taken - so maybe in the future astronauts can have steak and a salad instead of a packet of puree!

A R P A G W J S A T E L L I T E O E  
 A H O L I O C A R B O N F I B R E M  
 A Y L U G G C P U Q W T M R M I P O  
 V D Y M W T I T A N I U M I J X B E  
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FUEL	MATERIALS	RADIATION	RADIO
HYDROGEN	ALUMINIUM	POLYETHYLENE	SATELLITE
HYDRAZINE	TITANIUM	LEAD	INTERNET
BIOFUELS	CARBONFIBRE	COMMUNICATION	EXERCISE



## HUMAN FACTORS ENGINEER

*Designing systems and interfaces that consider human capabilities, limitations, and safety for astronauts during space missions.*



## SAFETY ENGINEER

*Identifying and mitigating potential risks and hazards associated with space missions, including launch and landing operations.*

Have you  
 been  
 collecting  
 the  
 careers as  
 you go?

# YOU DID IT!



**We've had to think about lots of things to help Zoom build the very best Moonpod for his journey home!**

What **MATERIALS** to use

What **FUELS** we could choose

How we can **PROTECT** Zoom from the cosmic radiation in space

The different ways to **COMMUNICATE** with Zoom and the Moonpod

And how Zoom can stay **HEALTHY** on the way!

As we've seen, there are lots of choices to be made and for every choice there are advantages - things that are helpful - and disadvantages - such as higher costs, weight or environmental impacts.



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