Active Debris Removal

The mission to clean up space



Activity pack

UK SPACE AGENCY

Association for Science and Discovery Centres

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The UK Space Agency is on mission to clean up space

In 2029, the UK Space Agency is launching a spacecraft to tackle the growing problem of space debris. In a world first, the high-tech spacecraft will use its giant robotic claws to grab two dead satellites and remove them from orbit. Clearing this 'space junk' will protect active satellites which we rely on every day.

This **resource pack** will guide you through the context of this pioneering mission and why it matters. It contains a range of accessible and hands-on activities to try yourself, or with your learners, to teach them more about space sustainability satellites and how space is... running out of space!



Visualisation of the ClearSpace UK spacecraft that will be launched as part of the UK Space Agency's mission. Credit: ClearSpaceUK

Name the mission!

Make your mark on history by naming this first-of-its-kind mission! The winning name will be etched onto the side of the spacecraft and will appear on the mission patch. Find out more on **page 7**.

How has space got overcrowded?

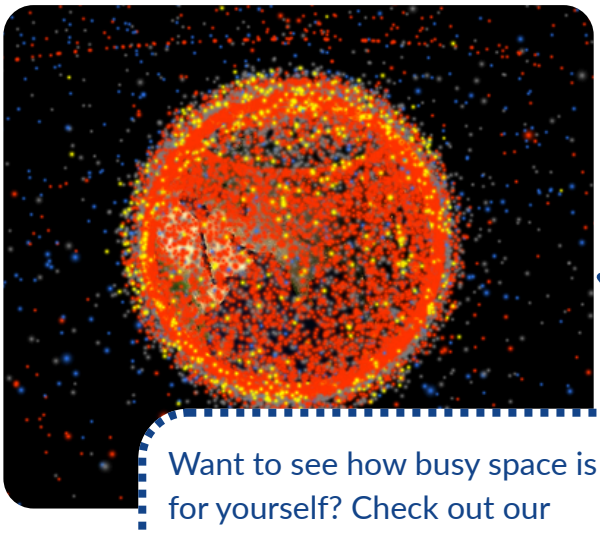
Satellites orbiting the Earth have become an integral part of our everyday lives. We rely on them for GPS, weather forecasts, our mobile phones and online banking. They've also transformed many areas of science, helping us study a huge range of things – from animal tracking, to rainforest density, to the patterns and causes of natural disasters.

The benefits of satellites mean the number of them in orbit has rapidly increased over the last 15 years. Most of them are in **low Earth orbit**, and this is the part of space that is getting particularly overcrowded.

Unfortunately, it is not only active satellites we need to keep track of. There is also a lot of **space debris**, or **space junk** - non-functional, human-made objects. This includes old satellites that no longer work because they've run out of fuel or suffered a fault, parts of rockets and other objects left behind in space.

As of November 2026, there are about 57,150 pieces of inactive space debris that are larger than 10cm*, and many millions more that are smaller.

Often, things in low Earth orbit will fall into the Earth's atmosphere and burn up, but this doesn't always happen. That means many objects stay in orbit, taking up vital space.



Want to see how busy space is for yourself? Check out our **What's in space?** activity on **page 8**.

Did you know?

There are nearly **13,000 working satellites** orbiting Earth today, and thousands more are launched every year. By 2030, there could be around **60,000** working satellites in Earth's different orbits.

Find out more about how we use satellites on the Desination Space website.

* Statistic updated regularly on this website

Why does this overcrowding matter?

Low Earth orbit: A limited resource

This overcrowding means we are simply running out of space in (this part of) space. Low Earth orbit is a finite resource, so we need to clear away the old to make way for the new. If we don't, we may become unable to send anything else up there.

Debris damage

All this space junk also poses a threat to current active satellites which carry out essential services. These pieces of debris are travelling at incredible speeds, around 10 times faster than a bullet! If they collide with our working satellites, it could damage or destroy them, affecting important services that we rely on every day.

Blocking the way

A build-up of space debris also makes space exploration more difficult. Any spacecraft needs to dodge the bustling traffic of our local orbit to reach the Universe beyond, risking getting caught in a catastrophic collision as it does.

There is even a theory that too much space junk in orbit could lead to something called Kessler Syndrome - a chain reaction of collisions that would eventually make parts of Earth's orbit unusable.

To understand more about the **risks of too much space debris**, check out our activities on **pages 10-13**.

So, clearing some hazardous old satellites from low Earth orbit is critical for:

- Maintaining our current essential uses of satellites, such as GPS.
- Developing future beneficial uses of satellites and spacecraft in low Earth orbit.
- Continuing our exploration of space beyond our local orbit.

This is where the UK Space Agency's latest mission comes in.

What is the UK Space Agency going to do?

Knowing we need to take a more proactive approach to removing space debris, the UK Space Agency have announced their **Active Debris Removal (ADR) mission**. As the name suggests, this mission will **actively remove** some of the **debris** that's clogging up space. Just like we clean litter from the streets and oceans, this mission will help remove litter from space to make it safer for everyone.

A specially designed spacecraft built by **ClearSpace UK** will use a robotic claw – similar to those used in an arcade claw grabber game - to grab two old satellites that no longer work. Equipped with advanced British robotics and autonomous navigation technology, it will gently guide them out of low Earth orbit, back towards Earth, where they will safely burn up in the atmosphere.

Launching in 2029 from SaxaVord spaceport in Scotland the ADR mission is a **world first** – a spacecraft has never disposed of more than one satellite in this way before.





Have a go at catching debris yourself or designing your own space-cleaning craft with our activities on **pages 14-16**.



SaxaVord spaceport in Shetland, Scotland
Credit: SaxaVord

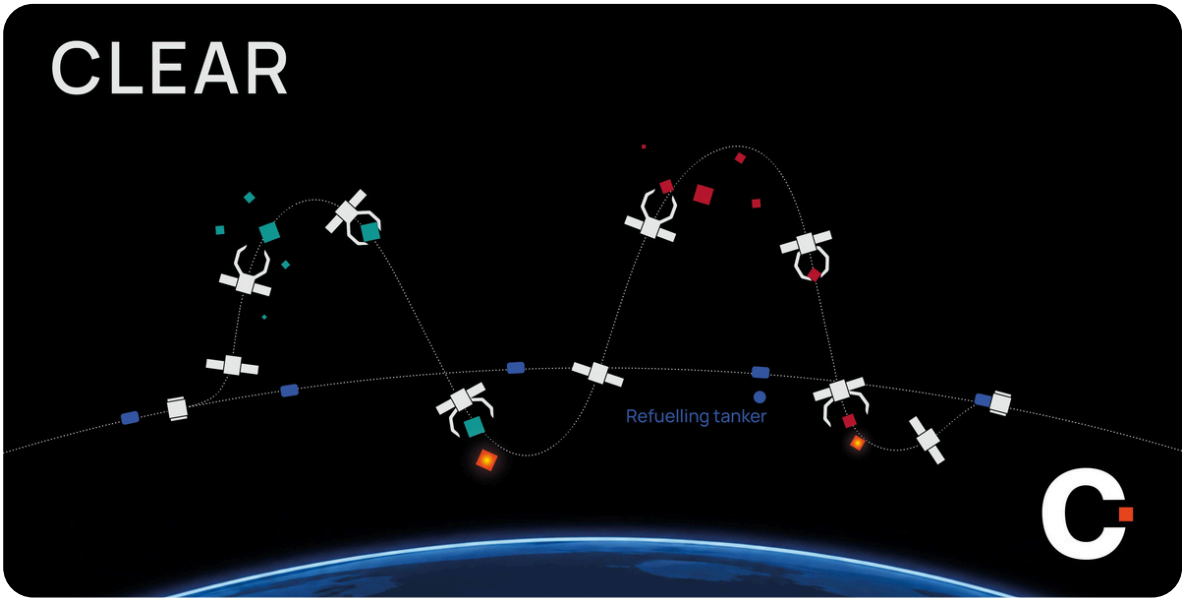
Benefits for future generations

The ClearSpace UK spacecraft is refuellable and designed so it can keep cleaning space for years to come. But the benefits of this mission go beyond one spacecraft – the technology developed, and the things we'll learn from it, will help us in the future too.

At the moment, when many satellites run out of fuel, we can't send someone to fix them or move them out of the way. Learning how to safely get close to and interact with another object in space, as we will in this mission, means that future spacecraft could:

- refuel satellites so they can keep working for longer
- repair or upgrade them instead of replacing them
- remove old satellites and keep space cleaner
- build things in space that are too large or difficult to launch from Earth

Through this mission and beyond the UK is leading the way in space sustainability, taking action to protect and preserve the space environment for future generations.



Visualisation of the ADR mission: The spacecraft grabs a defunct satellite, pulls it out of orbit so it burns up in our atmosphere, then goes to collect a second and do the same. Credit: ClearSpace UK

Read on for **hands-on activities** you can do with your family, friends and communities - whether that's at home, at school, at your local science centre, or somewhere else! Each activity gives a little more information on a particular aspect of the ADR mission - from why it's necessary to how it'll work.

Name the mission competition!

Space missions are often given memorable names that help people connect with and understand their purpose. Inspired by exploration, discovery, science and mythology, these names become an important part of a mission's identity and legacy.

A good mission name can tell a story, reflect the mission's objectives, or capture the imagination of the public.

This mission still needs a name. That's where you come in.

The UK Space Agency are running a competition to name their pioneering ADR mission, and they want your ideas.

The theme for this competition is:

A name inspired by keeping space clean and safe for future generations

Entrants must provide:

1. A proposed mission name (maximum two words, can be an acronym)
2. A short explanation (maximum 150 words) including how the name reflects the theme

The deadline for this competition is 10th December 2026, 5pm.

Examples of previous famous mission names

Mercury: NASA's first human spaceflight programme, named after the Roman messenger god, symbolising speed and exploration.

Sojourner: The first Mars rover, named after civil rights campaigner Sojourner Truth, representing courage and pioneering spirit.

JUICE (**J**upiter **I**cy **M**oons **E**xplorer): The European Space Agency's mission to study Jupiter's icy moons and investigate whether they may contain the conditions needed for life.

Winners will:

- Have their mission name selected and included on the mission patch and the spacecraft.
- Receive a framed certificate signed by the Space Minister and UK Space Agency Director.
- Win additional prizes if aged 7 – 18!

Have you got a name idea that can inspire future generations, raise public awareness, and create a lasting identity for a mission that protects space services we rely on every day?

Become part of history. Submit your idea here by 10th December 2026, 5pm.

What's in space?

See how busy Earth's orbit is in real time using the 'What's in Space' website.

Kit list

- A laptop, phone or tablet with access to the internet. That's it!

Introduction

Many objects that orbit the Earth are being tracked. What's in Space uses this tracking data to create a real-time 3D map of them.

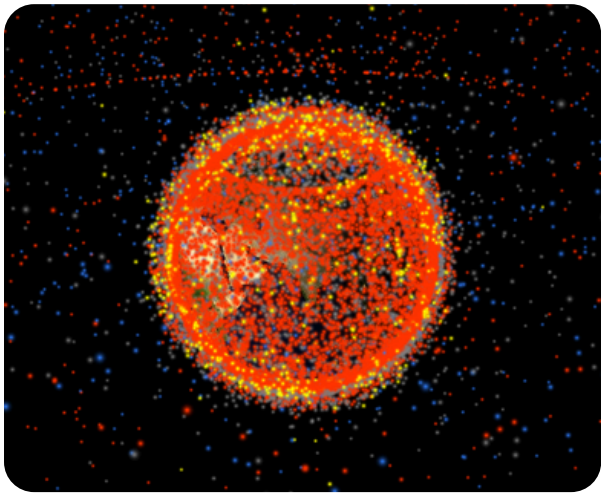
Orbiting objects appear as glowing dots surrounding Earth. As the website is based on real data, you can click on individual objects to find out more about them. Although low Earth orbit is the one that's getting overcrowded (as discussed in this pack), you can also see objects that orbit the Earth from further away.

The website updates daily with orbit data from Space-Track.org. It also uses the satellite.js Javascript library to calculate satellite positions.

Running the activity

Using a laptop, tablet or smartphone with internet access, open a browser window and go to the website whatsin.space.

Once on the site, familiarise yourself with the controls. Note the clock at the top of the screen. This should read the current time and date, showing that what you're looking at is a live visualisation of what is orbiting the Earth right now!



Screenshot from the What's in Space website showing overcrowding in the low Earth orbit

Things to explore

- Notice the dense area of yellow and red dots surrounding the Earth. This is low Earth orbit, and you can see how crowded it is!
- Zoom in and out of the image to move away and towards Earth, either using the buttons in the bottom right corner of the screen or your mouse controls.
- Click and drag the Earth to spin it around. Can you find a particular country?
- Click on individual orbiting objects. A line will appear showing the route it takes and a blue box will also appear with information it. Look out for:
  - The object's name (at the top)
  - The country it is from (shown by the flag next to the name)
  - The 'Type' of object it is – Payload, Debris or Rocket body. Their dots are also colour coded - see the next page for more information.

What's in space?

Dot colour code

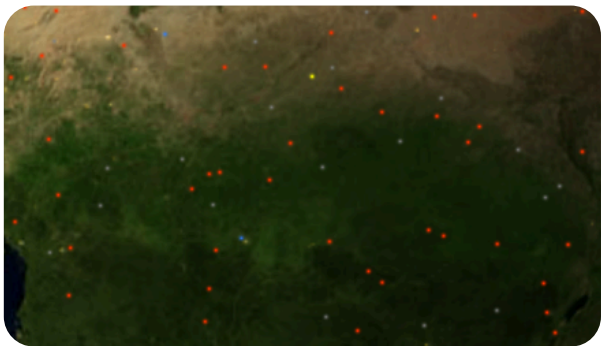
The blobs representing orbiting objects are colour coded depending on what they are.

Payload (Red): something that is producing data and sending it back to Earth, e.g. active satellites.

Debris (Grey): These are pieces of 'space junk' in orbit – for example the non-functioning satellites that the UK Space Agency mission will be removing!

Rocket body (Blue): These are also a type of debris. Rockets are used to deliver satellites into space. Once that's done, parts of them can remain in orbit.

Unknown (Yellow): These objects are tracked, but we don't have a lot of information about them!



Different coloured dots represent different orbiting objects.

Try out some of the site's more advanced features:

Speed up

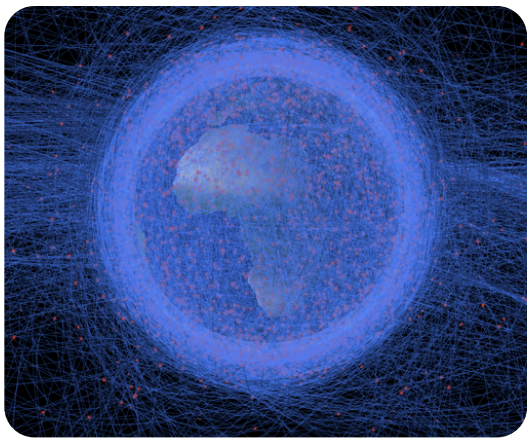
Use the X2 and X3 buttons to speed up the movement of the objects. This can help to visualise the bustling orbital environment. Clicking on X1 again will take you back to real time.

Filter by orbit

Click the BY ORBIT button on the top left of the screen and select 'Low Earth Orbit (LEO)'. This will highlight all the objects in our most overcrowded orbital environment, and the part of space that the ADR mission is focused on. With this filter, the orbital paths of all the objects are highlighted (not just the objects themselves), so it can look a little messier. However, it's still a good way of showing which objects are specifically in this orbit.

Filter by type

Click on the GROUPS button on the top left of the screen. Select the group you want to filter by. [Debris] is a good start. Remember, [Rocket bodies] are also a type of debris!



The 3D map filtered for 'Debris'

Collision dodging

Mimic our busy orbit and the risk of collisions between satellites and space junk. Can you squeeze through the gaps and avoid hitting anything?

Kit list

- Marbles or balls (up to 100)
- Large sheet of paper
- Marker pens or chalk

Introduction

The busier our low Earth orbit is, the more likely collisions are. Not only are active spacecraft and satellites at risk of being hit by space debris, but pieces of space debris may also smash into each other. This activity uses marbles to show how, as our orbit gets more overcrowded, it becomes more difficult to get through safely without a collision.

Set up

- Draw a picture of Earth in the middle of a large piece of paper or use chalk to draw it on the ground outside.
- Draw five concentric circular orbits around your Earth drawing.

Running the activity

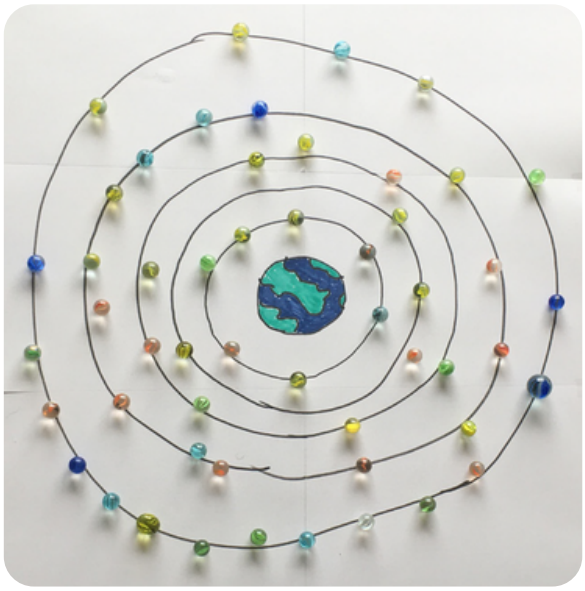
1. Place 10 of the marbles (or balls) onto your drawn circles representing orbits around Earth.
2. Each marble represents an active satellite or piece of space debris. It may be useful to use one colour of marbles for the space debris, and another for the active satellites. If this is not possible you might like to draw small circles around the marbles that are 'satellites'.



Example of the demo set up with 10 marbles. Credit: European Space Agency

3. Take another marble and, starting from outside the furthest orbit, push it across your drawing. This marble can either represent a spacecraft or satellite trying to make its way through Earth's orbits, or a piece of space debris falling out of its orbit into others. **If you want to act like a real space agent – try to avoid hitting the other marbles!**
4. Repeat this three times and notice what happens – does the marble you pushed hit any of the others? Does this happen every time? Is it easy to avoid hitting the other marbles?
5. Now put more marbles onto the different orbits and repeat what you did before, noticing the difference. Steadily increase the number of marbles, exploring at what point it becomes almost impossible to avoid them hitting each other.
6. Eventually, put all your marbles (other than the three you'll be rolling into them) onto the orbits. Is it possible to get anything through without a collision?

Collision dodging



The demo set up with 50 marbles. Credit: European Space Agency

Think about it...

Did any marbles representing working satellites get hit?

What would be the consequences if this really happened?

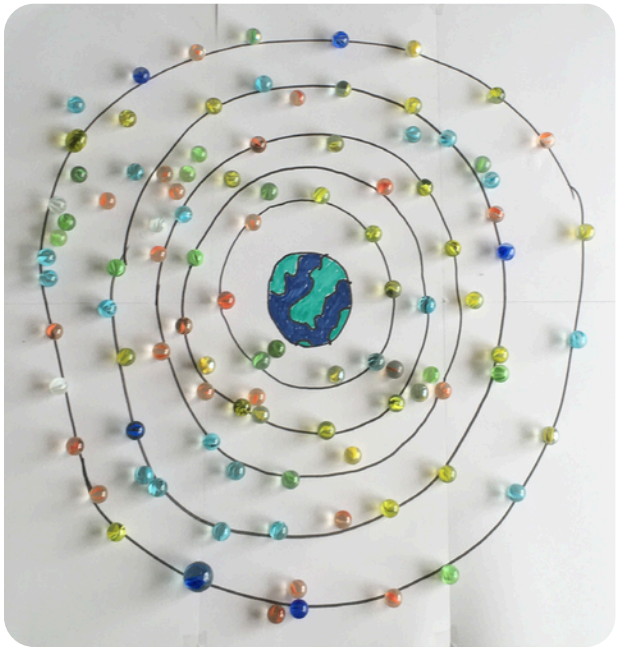
How would that affect us on Earth?

Extension: Introducing Kessler Syndrome

When objects actually hit each other in space, any parts that fly off them also become space debris. Imagine two large objects totally destroying each other – they would smash into lots of pieces. That would produce a lot more debris. You can explore this in our next activity, **Collision damage** (**page 12**).

NASA scientist Donald Kessler theorised that if there was too much space junk in orbit it could result in a chain reaction where objects collide and create more fragments in the process, which in turn will collide with other objects. Explore Kessler Syndrome further in our **Kessler Syndrome Board Game** (**page 13**).

You can see these chain reactions of collisions happening with the marbles. However, in this demo one collision might knock a marble into other marbles. In reality, it is as if one marble collision sends out hundreds more marbles!



100 marbles in orbit! Credit: European Space Agency

Top tip!

Take a before and after picture of your marbles to fully compare the impact of any collisions.

Collision damage

Replicate the damage that can be done to spacecraft in orbit to explore the impact of high-speed collisions.

Kit list

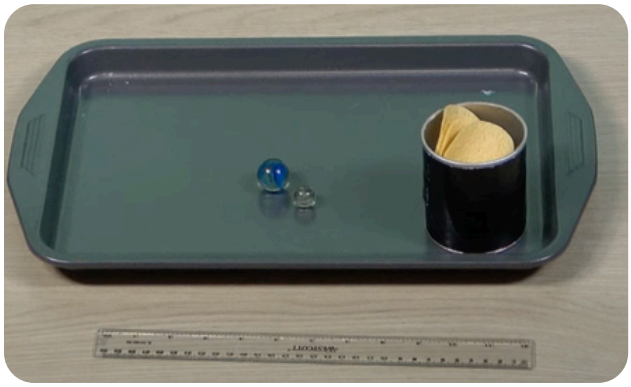
- Marbles (and any other object you want to safely drop)
- Crisps (Pringles or similarly shaped crisps work well
- Deep sided tray or box
- Ruler

Introduction

If pieces of space debris collide with anything else in orbit, the effects could be catastrophic. Active spacecraft could be seriously damaged or destroyed, not only affecting our ability to use them, but simultaneously sending more pieces of space debris into the atmosphere. Explore the factors that effect how much damage is done by such a collision using marbles and crisps.

Running the activity

1. Place a crisp in the tray
2. Use the ruler to decide a height to drop the marble from. This demonstration works best when you start small (so close to the crisp), then increase the height as you go along.
3. Drop the marble onto the crisp. Count how many fragments the crisps has broken into. Note down the height and the number of fragments.
4. Repeat several times from different heights using fresh crisps, noting down the results each time.



Equipment needed for this activity. Credit: European Space Agency

The marble picks up speed as it falls. This means that the higher the point you drop the marble from, the faster it will be going when it hits the crisp. What effect does this speed have on the collision?

Other things to try

There are a range of things that can impact how much damage is done by a collision. How do your results change if you:

- Drop objects of different masses onto the crisp.
- Drop the marbles onto several layers of crisps.
- Change the crisp for a different material.

Dropping a marble several times on the same crisp also shows that pieces of debris can be broken into smaller and smaller pieces with further collisions.

If your organisation took part in ASDC's Destination Space project, **the pressure rocket** demonstrates how small items can do a lot of damage when shot at high speed.

Kessler Syndrome: The Game

Try to avoid a catastrophic chain reaction of space debris collisions in this ADR-themed board game.

Kit list

- Printed copies of Kessler Syndrome – The Game. Download this here.
- Guidance for printing:
  - A3 on card is recommended. Or A3 on paper then laminated.
  - The cards are double sided, if two-sided printing on card is not an option, they can be printed on paper and laminated, or thicker paper.
  - It is recommended to cut out the game tokens and laminate or print on card for ease of use in picking them up.
  - Print a copy or two of the rules for each set as a reference.
  - Dice – You will need at least 1 dice (die) per set, although 2-3 are recommend to keep the game moving along.

Introduction

Kessler Syndrome is NASA scientist Donald Kessler's theoretical scenario that if there is too much space junk in orbit it could result in a chain reaction of collisions that produce more and more debris.

If this happens, there is a risk that certain parts of Earth's orbit become unusable, potentially setting us back to the pre-space age. This event is known as Kessler syndrome. If we do not change the way we use low Earth orbit, some experts think Kessler syndrome will occur in the next 50 - 100 years.

In this board game, players work together to clear space junk and prevent Kessler syndrome. They can do this by using their actions to move space junk out of orbit.



The Kessler Syndrome Game board

Running the activity

- Instructions for how to play the game are provided alongside the download of the game itself. Read through the instructions before starting to familiarise yourself with how it works.
- The game can be played with 1 – 4 players, with players controlling individual or multiple satellites or deciding how they act as a group. Larger groups can play, but they will need to decide as a group or in teams how the 4 satellites act.

For younger audiences

The game rules can be adapted for younger audiences. In this version:

- Remove disaster cards.
- Remove missile cards.
- All junk moves 2 spaces in its turn.
- No additional junk is added.
- The aim: to clear all the staring 9 pieces of junk in 4 turns.

Catching satellites

Explore the challenges faced by the spacecraft sent to catch large pieces of space debris.

Kit list

- Litter pickers / grabbers
- Clothesline / sturdy line
- Pegs
- String
- Objects to act as space debris. These could be model satellites that learners have made, balloons, or even household debris from the recycling bin!

Introduction

Cleaning up space debris is a challenge. We need to catch satellites that are often only a few metres across, travelling at incredible speeds, hundreds of miles above Earth. Spacecraft, known as chaser satellites, are being developed to carry out the task of catching and removing space debris. The ClearSpace spacecraft that will be used in the UK Space Agency mission is an example of this.

Set up

- Set up a clothesline with space around it.
- Tie string to the line for objects to be attached to.



The ClearSpace UK spacecraft's will use a claw to catch space debris. Credit: ClearSpaceUK

Running the activity

1. Attach the string with satellites on to the clothesline using pegs to create a busy "low Earth orbit" filled with satellites.
2. Identify the challenges of trying to catch satellites which have become space debris (e.g. travel speed, the size of them compared to endless space).
3. Use the grabbers to catch the satellites and pull them off the clothesline, thereby bringing them into earth atmosphere to burn up.



Use the litter picker as your own debris catching claw

Increasing the difficulty

- Rock or move the clothesline to simulate the difficulty of trying to catch satellites as they tumble through space.
- Specify that certain satellites on the clothesline must not be touched as they are still active.
- You can also use a rotary washing line to further simulate satellites orbiting around earth. Use soft objects for satellites if you do this.

Stopping satellites

Design and construct a chaser satellite that can hold onto a piece of space debris and pull it out of orbit.

Kit list

- Slingshot / catapult / individual who can throw
- Ping pong balls or similar objects to act as space debris.
- Craft consumables such as sticky tape, scrap paper and card, straws, pipe cleaners
- Craft tools such as scissors
- Cones or flags to mark places on the ground

Introduction

Chaser spacecraft are designed to deorbit space debris that they capture. This is done by physically pushing or pulling on the debris. In the ADR mission, once the chaser craft captures its target, it will guide it closer to Earth. This will cause a 'destructive re-entry', where the space debris burns up in the Earth's atmosphere.

Designing chaser satellites that are versatile enough to capture objects of different shapes and sizes, which may be broken and tumbling wildly through space, is an engineering challenge. In this activity, you can tackle the challenge for yourself!

Set up

- Make sure you have space to safely throw the object acting as space debris.
- Gather enough craft materials for everyone taking part.

Running the activity

1. Stand with enough space in front of you to throw your objects. Mark where you are standing. This point represents Earth.
2. From this point, catapult or throw your piece of space debris. Mark where it lands. This is your control distance, and represents the low Earth orbit your piece of space debris is travelling in.
3. Your challenge is to design and build a chaser satellite that can hold onto the space debris so that when it is catapulted or thrown, it does not travel as far as the control. This represents the space debris being deorbited and pulled towards Earth by your chaser craft.
4. Decide what will make a successful design. For example:
    a. Chaser spacecraft must remain attached to the space debris.
    b. Include size restrictions for the chaser as they need to fit inside a rocket for launch.
    c. Space debris must be kept separate until just before launch as we cannot build chaser spacecraft around space debris (i.e. you can look at the debris, but don't touch it)
5. Choose a piece of space debris. For more of a challenge, choose a piece of debris, measure its dimensions, then hide it again.

Stopping satellites

6. Use your craft materials to design and build a chaser craft for your specific piece of space debris. Set a time limit if you want to make this more difficult!
7. Attach your chaser craft to the space debris and catapult / throw it from the original mark. If you meet the success criteria, you win!



A homemade chaser craft next to the space debris it will capture

If your organisation took part in ASDC's Destination Space project, use **the robotic arm** to communicate the chaser craft complexities further. Specifically, this can show the **time delay** between telling it what you want it to do and it actually doing it!

Think about it...

What does the best chaser satellite need in its design?

What can be done to make satellites easier to remove if they become defunct?

What would happen to chaser satellites if they missed their target?

Why would engineers need to test a chaser satellite many times before launching?

Working with groups

Turn this activity into a competition between groups. Provide each group with the same craft materials, and run the activity as before.

Competing people or teams can launch rivals' satellites, or have a single person launch all for consistency. The winner can be decided by how many of the success criteria each chaser satellite achieves.

You can make it extra hard for the groups by only providing them with the dimensions of their piece of space debris without showing it to them. The first time they will see it is when they need to attach their chaser craft!

Take our space debris quiz now!

Think you've got what it takes to be a space cleaning master? Got something to say to the ADR mission team?

Take our online quiz and send a message to the UK Space Agency

Further resources

Explore the resources below to discover more about the UK Space Agency, the ADR mission and beyond.

More information

- UK Space Agency's official website
- What is Active Debris Removal?
- How will the UK Active Debris Removal Mission work
- SaxaVord's website

Educational resources

- Space-related educational resources from the UK Space Agency
- Destination Space website: includes information on how we use satellites, interviews with space explorers, and more!

Space careers

- Discover more about careers in the space industry
- Ideas about space careers provided by the UK's national student space society, UKSEDS

This resource pack was created by the Association for Science and Discovery Centres (ASDC) in collaboration with the UK Space Agency. Find out more about ASDC's work on our website.

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