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Kit No. 9

Science Debate Kit: Mars Mission

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Debate Kit: Mars Mission

Should we send a human mission to Mars?

A structured practice debate on a controversial topic.
The different 'rounds' of the debate help students think through the issues and reconsider their opinions.
The structure also shows them how to build a discussion and back up their opinions with facts.

You can use all eight characters, or fewer, as you wish.

The minimum is the four essential characters **(in bold)**, this gives two for and two against.

Characters

Yes – We should send a human space mission to Mars	No – We should not send a human space mission to Mars
• **Bill McIntosh – Spacecraft engineer**	• **Penny O'Hara – Helicopter pilot**
• **Sarah Oakes – Politician and space enthusiast**	• **Robert Pinxton – Astrobiologist**
• Sudarat Jaa – Planetary geologist	• Greta Stevens – Spacecraft engineer
• Derek Amundsen – Physiologist	• Kai Buchanan – Ecologist

Facilitation tips

Ensure pupils know there is no right or wrong answer.
Be observant of ones who want to speak and are not getting a chance.
Encourage students to give a reason for their opinions.

KS4: These debate kits have been used with ages 11-18

For groups who may need extra support you can put the following prompt sentences upon the board:

"I think we should/shouldn't send humans to Mars because……."
"I think …… is the most important point to think about."

Learning notes

Learning objective:

- To practise discussing and debating issues and expressing an opinion.
- Understand more of the technical, physiological, social and ethical issues around human space exploration.

Other learning outcomes:

- Consider social, ethical and factual issues in an integrated way.
- Think about different points of view.
- Learn to back up their opinions with facts.

Curriculum points covered:

Working scientifically
- Understanding of the limitations of science and ethical issues which may arise.
- Evaluating personal, social, economic, and environmental implications and making decisions based on evidence and arguments.
- Evaluating risks and the perception of risks in the wider societal context.

Teacher Notes

Question:
Should we send a human mission to Mars?

Lesson plan

The different 'rounds' of the debate help students think through the issues and reconsider their opinions. The structure also shows them how to build a discussion and back up their opinions with facts.

Starter: 5 minutes.
What do they know about humans in space? When did the first humans visit space? Are there any humans in space now? Thinking about what they know about human bodies, what are all the things that our bodies need, that are hard to get in space?

Main Activity: 35 minutes.
1) **Split students into** as many **groups** as characters you want to cover.
2) **Give** them their **character cards** – one per group, and give them a few minutes to read them over.
3) Get one student in each group to **read out** their **first section** to the rest of the class. What are the class's initial thoughts? Is there one position they identify with or reject?

KS4: These debate kits have been used with ages 11-18.

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4) Take it in turns to read out their fact. Does it change the way they think?
5) **Read** the **issue**. Any different feelings?
6) Each team **asks** their **question to** the **character of their choice.**

Support: To help students you can put the following prompt sentences up on the board:
"I think we should/shouldn't send humans to Mars because……."
"I think ……. is the most important point to think about."

Plenary: 10 minutes
Vote for which position they agree with most (if there is one). Why? Which arguments were the most persuasive?

Note – Pupils can stay in roles all the way through the debate, or only for the first round if you prefer. If it's all the way through, give them a chance to express their own opinion at the end and in the plenary.

For groups who are not confident at class discussion, it might help to have them start by discussing the question and/or their character's position in pairs, and then compare notes in fours. They've then had chance to rehearse some of what they want to say before having to do it in front of the whole class.

Background notes

NB, throughout this kit we have avoided any use of the words 'manned' or 'unmanned', in line with official Nasa style guide. Interesting discussion of this https://storify.com/elakdawalla/finding-new-language-for-human-missions

Mars is the fourth planet from the sun in our solar system. It is a 'terrestrial planet' (i.e. Earthlike), meaning it is composed mainly of silicate rocks and metals and has a solid planet surface (unlike the 'Giant planets' like Jupiter and Saturn). It has a thin atmosphere.

Mars facts-at-a-glance

- Mean radius: 3,390 km (about 53% that of Earth)
- Mass: 6.42 x 10^{23} kg (or 642 sextillion kg, about 11% that of Earth)
- Surface gravity: 3.71m/s² (about 38% that of Earth)
- Average temperature of atmosphere: -63°C (cf 15°C for Earth)
- Length of year: 687 Earth days
- Length of day: 24hr 40mins

Human missions to Mars?

There are many arguments for and against sending humans to Mars (this is why we made it the basis of a debate kit!). But practically speaking, we'd have to solve a lot of issues first.

Things we don't know yet:
- How best to shield astronauts from cosmic radiation on the journey there and while on the surface of Mars.
- How to launch a spacecraft into space, from the surface of Mars for the return journey. We've had lots of practice at launching spacecraft from Earth, but we'll have no chance to practice on Mars. We'll probably have to mine fuel from Mars in some way (as we won't be able to take enough with us), but we don't know what, how, or when.
- We don't know enough about the long term physiological effects of space travel and how to mitigate them.
- We also don't really know how to keep humans alive all the way there, on Mars, and then all the way back – providing air, water, food, keeping them warm, combatting the effects of microgravity, dealing with waste. Either we need to develop much better technology than we have now to do all these things. Or we send an enormous craft, which will be unfeasibly expensive to build and launch.

In a sense, it's mainly the sending bodies into space (and safely back) that makes it difficult, as we've already sent numerous robotic craft. Human bodies are of course optimised for the temperature/pressure/gravity/radiation levels found on Earth. It's said it takes a day on Earth to recover from each day in space.

Being in extremely low gravity means reduced loading and disuse of weight-bearing tissues - muscles waste away and bones lose mass. Fluid is no longer pulled into the lower body by gravity, so pools in the upper body. The body responds by reducing blood volume. When astronauts return to 1g, they don't have enough blood volume and their heart muscles and circulation are weak. Crew on the International Space Station (ISS) exercise for 2.5 hours a day, but they are still taken off to hospital in a wheelchair when they get back to Earth (which is why you never see triumphant returning astronauts waving for the news cameras).

The longest anyone has spent on the ISS is one year. We don't know what the effect of two years or more would be.

As part of the research for this kit, we spoke to Chris Welch, Professor of Astronautics and Space Engineering at the International Space University in Strasbourg. He said, "There are so many variables in how a human mission to Mars would work, it's a fascinating problem. To be honest, it's what spacecraft engineers do when we are bored: design different fantasy missions to Mars, to see if we can find a new way of making it work."

For example, with present technology it would take roughly 7 months to get from Earth to Mars, if the journey is timed to take advantage of when they are closest to each other. (The nearest they ever get is about 54.6 million km, the furthest apart they ever get is about 401 million km, when they are at opposite ends of their orbit, and the Sun is in between them). So if timed right, people could go to Mars and stay a short time (a couple of weeks), and then set off back while the two planets are relatively close. Or they could wait on Mars for about a year until they can hit another close approach. (There is roughly 26 months between closest approaches, but obviously you have to set off months beforehand, heading for where you know the planet is going to be when you get there.)

Other variables are how big a craft we'd send, whether the whole craft would land on the surface, or (more likely) the bulk of the craft would stay in orbit around Mars and a small lander module would land on the planet. What kind of habitats astronauts would live in on Mars, and how these would get there/be built. What fuel the return trip would use. It's possible to send robotic craft with cargo to Mars before the human mission, so that supplies are waiting there when the astronauts arrive. But the astronauts would still have to find these on the surface and assemble habitats, etc.

At best there would be a 20 minute lag for communications to Mars. At some points the Sun would be between Mars and Earth and the astronauts would be incommunicado for days or weeks. The crew would probably be four or five people. It would be a difficult mission psychologically. Space agencies are working with psychologists who study 'isolated and contained environments' (for example, the Antarctic research base) to help them work out how to choose and how to train astronauts for a mission like this.

Other resources:

The UK Space Agency and its partners have put together a programme of education activities related to the Principia mission. principia.org.uk/get-involved/

ESERO-UK provides free resources, support and information for teachers to enhance the teaching and learning of STEM using space as a context. stem.org.uk/esero/

We have collected a range of resources which can be used with this kit at: debate.imascientist.org.uk/mars-debate-kit-resources/

Debate

Robert Pinxton – Astrobiologist

I am a scientist who looks for evidence of life on other planets. The more I study, the more I realise that we just don't know what life on other planets would be like. Everything we know is based on the life we see here on Earth. We could be completely missing living things, just because they are nothing like what we recognise. There could be life on Mars, and we could accidentally contaminate the planet and destroy it.

Fact: Some interstellar dust is made of organic molecules. Some people think that life on Earth is all descended from viruses brought by comets.

Issue: We can't be sure there is no life on another planet before we get there. But we could destroy that life by going to look.

Question: What right do we have to go and contaminate other planets, just out of curiosity, like a spoilt child?

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Debate

Penny O'Hara – Helicopter pilot

I was a mountaineer in my youth, and climbed some of the most dangerous mountains in the world. Now I fly a mountain rescue helicopter. I understand what makes people want to explore and take risks, but looking back, I was an idiot. Every day in microgravity, people's muscles and bones get weaker, their hearts get weaker. Every day on the journey and on Mars they'd be exposed to levels of cosmic radiation that we don't know how to shield them from. We don't even know the long term effects of these things.

Fact: It takes about a day on Earth to recover from a day in space. So two years in space would take two years to recover.

Issue: I don't think we as a society should send people on such a dangerous mission, even if they say they want to go.

Question: Would the people who are so keen on the idea be happy if their brother or sister was going on the trip?

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Debate

Kai Buchanan – Ecologist

I study desertification – how land turns into desert and stops being able to produce food or support plants and animals. Deserts are growing all over the world. I'm horrified that people talk about a Mars mission like it's a lifeboat for humans. We can't just give up on Earth, our home, and run away to another planet. We should stay here and put our energy into trying to fix this one.

Fact: It costs £10,000 per kg just to launch things into a low Earth orbit. A mission to Mars will cost hundreds of billions of pounds.

Issue: I think that money and all that brain power would be better spent trying to solve our problems here on Earth.

Question: Shouldn't we work out how to live sustainably on this planet before colonising a new one?

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Debate

Derek Amundsen – Physiologist

Physiologists study how the bodies of living organisms work. I specialise in how the human body responds to extreme conditions. We can learn so much by studying what happens to our bodies in space. And it's a fascinating challenge, working out how to design spacecraft and equipment to protect human bodies from space radiation, low temperatures, and the effects of microgravity. The hard thing about a mission to Mars is keeping humans alive on the space flight and when we get there.

Fact: Humans have evolved to live in the tropics. Our bodies are comfortable at 28°C, 1g of gravity, and 1 atmosphere of pressure. We can live in colder climates, because we invented clothes and houses.

Issue: We can find out so much we can't here on Earth.

Question: We could learn so much about health by studying the body's response to new environments. Are we really going to pass up this opportunity?

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Debate

Sarah Oakes – Politician and space enthusiast

I think sending humans to Mars could be the Moon landings for a new generation. More than that, it's an incredible, amazing goal. Mars could be the start of the next phase for humanity. It will inspire so many people, and new inventions. I think it is our human destiny to do this. It could bring us together as a species, give us a common goal.

Fact: Many famous and successful scientists and engineers today were inspired by seeing the Moon landings when they were children.

Issue: The space race had dozens of spin-offs – technology that was developed for the space programme, but then has been useful on Earth too. Including lifesaving ways to detect cancer cells and many other medical improvements.

Question: Are we really going to just sit here on Earth, while there's a whole universe out there to explore?

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Debate

Bill McIntosh – Spacecraft engineer

I've spent my life studying and designing spacecraft. Of course I want us to send people to Mars! Partly just because it would be really amazing to see. But far more seriously - sooner or later we need to leave Earth, or we'll all be wiped out. Mars would be a first step and staging post.

Fact: So many things could destroy life on Earth. Climate change, nuclear war, we could be wiped out by an asteroid, like the dinosaurs, and we're overdue a super-volcano eruption. Or, if we last that long, our sun will burn out in 4.5 billion years.

Issue: While all the humans are on Earth, it's like we've got all our eggs in one basket. It's too easy for us to get obliterated!

Question: How else can we develop all the technology and knowledge we need to send humans into the rest of the solar system?

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Debate

Sudarat Jaa – Planetary geologist

It's so tantalising seeing the bits of data that the Mars Rover has sent back. But it's so limited. Robots can't 'think on their feet', they can't interpret what they see and think of another question to ask or experiment to do. I'm just itching for us to send up a geologist with a hammer! We know Mars used to be more like Earth, with water and an atmosphere. What happened to it? Finding out could tell us a lot about Earth and our possible future.

Fact: It can take weeks of programming just to get the Mars Rover to go back ten metres and take another look at an interesting-looking rock they passed.

Issue: A team of people could find out more in a week than robot probes could in years.

Question: Don't you think we should go to Mars to learn as much as possible about what Earth's future might hold?

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Debate

Greta Stevens – Aerospace engineer

I totally agree we need to send humans into space as a safeguard, like a sort of lifeboat if something happens to Earth. But I think Mars is the wrong mission. Too far away, too inhospitable, too difficult! We should start with a colony on the Moon.

Fact: We can get to the Moon in 3 days. The quickest journey to Mars would be about 7 months one way. And that's when Mars and Earth are at their closest, which only happens about every 2 years.

Issue: It's so much easier to get to the Moon, and to bring people or equipment back if there are any problems.

Question: What happens if someone falls ill or a crucial piece of equipment fails on Mars? It could be years before we could get there to help.

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