Student Pack

2023 Challenge

Version 2

Table of contents

What is the STEM Challenge?

The Science, Technology, Engineering and Maths (STEM) Challenge is an exciting competition where students like you can use your creativity and scientific knowledge to solve a future world problem. Entries will be judged by a panel of civil servants from across government and prizes will be awarded to the groups with the best solutions!

This year's challenge will focus on **'A vision of a carbon neutral day in 2050'**:

Carbon dioxide (CO_2) is a greenhouse gas present in our atmosphere. Greenhouse gases absorb heat radiated from the Earth and then release energy in all directions, which keeps the Earth warm. If levels of carbon dioxide rise this leads to an enhanced greenhouse effect causing global temperature increases, the melting of polar ice, and rising sea levels.

Carbon dioxide is released when fossil fuels are burnt to generate electricity, and to run our cars and homes. Being **carbon neutral** involves removing the same amount (or more) of carbon dioxide from the atmosphere than the amount released. For example, planting trees removes carbon dioxide from the atmosphere through photosynthesis. Carbon neutrality can be achieved through resource management and innovation, which is what we want to hear about from you!

Being carbon neutral is a government objective for 2050. As policy makers, and scientists, you have the opportunity to influence the UK's climate change efforts by creating ways to become carbon neutral.

Your group will take on the role of **scientists** and **policy makers** in the year **2050**. You will be responsible for ensuring resources are managed in a **sustainable** and **carbon neutral** way.

- Policy refers to government laws, ideas and procedures. It is how we, as civil servants, make legal changes to improve our country.
- In the challenge your team will show us what ideas you can come up with that the government could use to tackle climate change.

Policies to become carbon neutral must also be **sustainable**, which means the solutions aren't short-term and can be maintained.

An unsustainable solution would be to stop using fossil fuels for one month. While this would reduce greenhouse gas emissions, it is a short-term solution and would cause other problems, such as where we would get our electricity from. This couldn't be maintained as a long-term policy.

A **sustainable solution** may also consider areas such as:

Biodiversity: avoiding species becoming extinct, having a range of plants and animals living in an area.

Effectiveness: it must still reduce overall greenhouse gas emissions.

Ethical implications: the solution must be fair! Will any group of people be negatively affected by your ideas?

In your groups, you will choose one of these three problem statements to write your report or poster on. Use your problem-solving and creativity to come up with innovative solutions and ideas for making your chosen problem statement more sustainable!

Sustainable food production

Humans in space

Sustainable transport

Why participate?

1. Prizes!

Every participant will receive:
- A signed certificate from the Government's Chief Scientific Adviser and National Statistician.
- A talk from government scientists and statisticians for your class and videos to watch from STEM leaders in Government.
- Resources to learn more about science.

On top of that, the winning team will receive prizes that include:
- A year's subscription to The Royal Society of Biology's BioNet membership.
- Engagement from the National Physical Laboratory and Royal Astronomical Society.
- The top three teams will receive Amazon vouchers and engagement from Learned Societies.

2. Knowledge

The challenge is a great way to learn about how science is used to create new government policies. We hope this will show you how science is important outside of the classroom and that it can be applied in jobs outside of a laboratory.

Participating in the challenge could be a great thing to include in a CV or university application to show how you have developed key skills such as creativity, problem-solving and teamwork.

Challenge areas
Resources for students

The following section details each area that each student group can focus on for the Challenge. Groups can choose any of the three problem statements.

*Please choose only **one** problem statement per team!*

Option 1: Sustainable Food Production

The world's population is estimated to reach 9.9 billion people by 2050. To feed the growing population, food production will need to be more efficient and sustainable. Sustainable food production involves producing food whilst protecting the land for future generations.

Imagine that you are in charge of creating policy for food production in the UK. **How will you make UK food production more sustainable?**

Research topic ideas to get you started:

- **Genetically modified (GM) crops**: What are the benefits and drawbacks of using GM crops? Who would be for and who would be against the use of GM crops? Have they been used anywhere before?
- **Alternatives to farming chemicals:** What effects can farming chemicals have on the environment? Are there ways to farm without using chemicals? Can we produce enough food without using farming chemicals?
- **Changing diets (insect consumption):** How could changing our diets improve sustainability of food production? What are the benefits and problems associated with including insects in our diets? Is lab-grown meat a realistic alternative to meat from animals?
- **Sustainable aquaculture and smart fishing:** Are there sustainable ways to catch fish? What issues are associated with fish farms? What are the latest technologies in aquaculture?
- **Land use:** How could land sharing or land sparing be used to improve sustainability of food production? What are the pros and cons of each system?
- **Reduce food waste during production or storage:** How could we minimise food waste in places like supermarkets and restaurants? Could technology help to reduce food waste? How could this impact farmers?

Websites to help with your research:
- BBC bitesize: http://www.bbc.co.uk/bitesize/topics/zjsc87h/articles/z88nhcw
- Food and Agriculture Organisation (FAO): https://www.fao.org/home/en
- Sustainable Food Trust: https://sustainablefoodtrust.org/

Option 2: Humans in Space

Space activities can benefit people back on Earth through space technologies, such as satellites for communication and weather monitoring. By advancing these space technologies, we can also progress scientific knowledge that may improve sustainability on Earth. We must also ensure that the space industry itself is sustainable, especially as it grows larger. This requires the consideration of the needs of people on Earth whilst also protecting space for future generations.

Imagine that you are overseeing the UK's space strategy: **How will you improve the sustainability of space exploration? How can you use emerging space technologies to improve sustainability on Earth?**

Research topic ideas to get you started:

- **Space food production:** How will you go about this task? What benefits might this have on earth? How might this help further space exploration?
- **Rocket fuels:** What sustainable issues result from current fuel options? What alternative could be used (biofuels)? What are the advantages and drawbacks from this change?
- **Reusable rockets:** What are the repercussions of one-time use rockets? What about safety? Are reusable rockets possible for full orbital flights?
- **Space tourism:** Are there benefits to humanity? What are the benefits to space exploration efforts (marketing, public opinions, etc.)?
- **International Space Station (ISS):** What science experiments are done on the ISS? How might this be beneficial to sustainability efforts on earth? What are the long-term impacts on astronauts?
- **Space technologies:** How might they improve sustainable development (natural disasters, reducing poverty, telecommunications)? How do they aid in reducing carbon emissions on earth? What are the drawbacks?
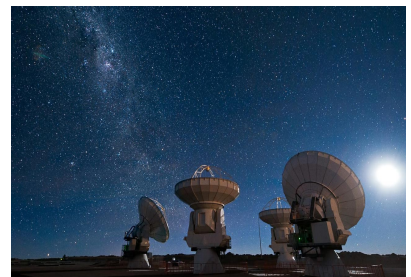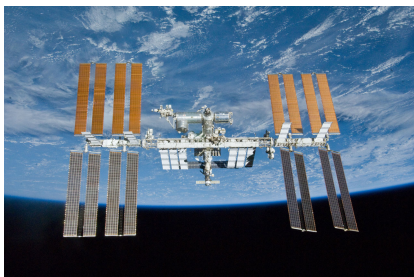
Websites to help with your research:

- UK Space Agency: About us - UK Space Agency - GOV.UK
- European Space Agency: https://www.esa.int/
- SpaceX: https://www.spacex.com/

Option 3: Sustainable Transport

Transport connects people to work, education, and healthcare, and enables the trade of goods. In 2019, the transport sector produced 27% of the UK's greenhouse gas emissions, the most of any sector in the UK. Since then emissions have fallen, likely as a result of less transport use during the COVID-19 pandemic, but transport remains one of the industry sectors producing the most CO_2 emissions.

Imagine that you are in charge of creating policy for the UK's transport system. **How will you make the UK's transport system more sustainable?**

Research topic ideas to get you started:

- **Electric vehicles**: How big an impact would it have if everyone used electric cars? What are the advantages and disadvantages of using them? Can any other vehicles be electric?
- **New fuel types**: Could new fuel types like biofuels or hydrogen be more sustainable than petrol and diesel? What are the advantages and disadvantages to using these different fuel types?
- **Personal choices**: What role do people's everyday choices have in creating a more sustainable transport system? What is the environmental impact of choosing to walk or cycle? What are the advantages and disadvantages?
- **Future modes of transport**: Are there any new or future modes of transport being developed that are more sustainable? What are the advantages and disadvantages? Will they be created soon enough to make a difference?
- **Air and water pollution**: What is the effect of unsustainable transport on air and water pollution? Are there ways to decrease it?
- **Green (sustainable) cities**: What are they? What are some examples? What role does transport have in making these cities sustainable?

Websites to help with your research:
- https://www.nationalgrid.com/stories/journey-to-net-zero-stories/future-transport-driving-change-next-10-years: This article has a good overview of lots of different topics, including new fuels and future types of vehicles.
- https://bettertransport.org.uk/: Campaign for Better Transport, and contains lots of their ideas on how transport can be made greener in the UK.

Submission Guidance

The STEM Challenge looks into the future and imagines how technological progress and science could overcome the sustainability challenge that we face today. This is your opportunity to showcase your scientific knowledge and ability to evaluate different ideas.

Please look at the problem statements below and choose one problem statement for your team to tackle.

Problem Statements

Transport

How will you make the UK's **transport** system more sustainable? ☐

Food

How will you make UK **food** production more sustainable? ☐

Space

How will you improve the sustainability of **space** activities? Or, how can you use space technology to improve sustainability on Earth? ☐

Worksheet Guidance

What is the purpose of the STEM Challenge worksheet?

The STEM Challenge worksheet should provide the scientific background information and reference the sources that were used to come up with your idea. This is your opportunity to showcase your scientific knowledge and ability to evaluate different ideas.

Use this checklist to help structure your report:

Abstract 10%

The abstract is a brief summary of your report, informing the reader of what you did and what you found out. This is to give the reader a complete, yet concise, understanding of your project. This includes:

- ☐ Project aims and scope
- ☐ A summary of the proposed solutions and conclusion

Introduction 20%

- ☐ Describe your chosen problem statement
- ☐ Explain why solving your problem is important
- ☐ Consider how this problem may affect you and others in the future
- ☐ Reference what the scientific community is currently doing to tackle this problem

Narrowing the Topic 5%

Your problem statements target wide-ranging issues so it is important to be clear on the specific area or issue you are targeting. For example, will your solutions aim to make UK rail travel more sustainable or will you focus specifically on the reduction of space debris.

- ☐ Describe the area of the problem statement you have chosen to focus on
- ☐ Consider why this specific area is important - what is the impact of not tackling this? How many people are affected? What impact does this have on climate change?

Proposed Solutions 25%

- ☐ Describe your three solutions to the problem area
- ☐ Explain how your solutions solve your problem area
- ☐ Use supporting evidence to support your argument. Evidence is anything that can be used as proof for your arguments. For example, if you are introducing a new, sustainable technology who invented it and how does it work?
- ☐ Comment on the reliability of your sources. Think about how trustworthy your sources are? Are they from a well known organisation or journal?

Discussion 25%

- ☐ Describe the advantages of your chosen solutions
- ☐ Describe the disadvantages of your chosen solutions
- ☐ Describe the uncertainties of your chosen solutions and suggest how they can be addressed. Consider if further research is needed to understand how your solution would work in practice?
- ☐ Consider the practicality and affordability of your solutions. How easy will they be to implement? How much time will it take? Think about the resources that might be needed.

Conclusion 15%

- ☐ Provide a summary of your main points
- ☐ Which of your solutions would you recommend to the UK Government and why?

References

References are the sources of your information. These sources can be videos, websites, articles, scientific papers etc. and should simply be included as a link or a note of the title and author. Your references will not be marked.

- ☐ Provide a reference list of all the sources of information you used. Include a source in your reference list whenever someone else's work or idea is mentioned in your report or poster.

Checklist for your Submission

Check your poster or report against this list before submitting:

☐ My team has read the student pack's success statements before starting our poster or report.

☐ My poster or report is in colours easy to read (light colours will not show up well when your submission is scanned in).

☐ The size of text in my report or poster is easy to read (we recommend font size 12, or handwriting that fits well on a normal lined page).

☐ My team's submission is no bigger than four A4 pages.

☐ I **haven't** included my name or my team members name on the poster or report

☐ My team has read the problem statement we have chosen, and have looked at all of the links provided before starting to come up with solutions.

☐ My poster or report has clearly indicated which problem statement we have chosen.

☐ My poster or report only addresses **one** problem statement.

☐ My poster or report has **three** solutions to the problem statement. It does not have more than three solutions.

☐ Each of our solutions has been evaluated, such as by adding a list of pros and cons.

☐ If I have made a poster, I have included images that match my problem statement, and maybe some charts or graphs.

☐ If I have made a report, I have included a chart or graph and have discussed this chart in my report.

☐ My team has read the referencing guide and understands what a source is, and why we need to list our sources.

☐ My poster or report has a list of sources, such as textbooks and websites (if you want to earn extra marks here, you can follow the 'advanced referencing' guide below!).

☐ My poster or report has a conclusion paragraph or section, which summarises what I have written in the poster or report.

Make sure you and your team are happy that all items have been ticked off!

Mark Scheme

This is the mark scheme that will be used by the judges. You can use this as guidance when writing your poster or report.

	Definition
Problem Solving	1. Outline which of the three problem statements you have chosen to answer and provide information on how it affects us, why it is important and what the science community is currently doing to address the problem
	2. Present three relevant solutions to your chosen problem statement and explain how each of these will help solve the problem
Evaluation	3. Evaluate the proposed solutions by suggesting how effective they would be at tackling the problem and identify any potential drawbacks
	4. Compare the practicality of putting each of the solutions into practice, including assessing the overall cost
	5. Consider whether there are any uncertainties or problems with your solutions and what other research may need to be carried out to address these
Scientific Evidence	6. Use evidence to back up the information used in your report or poster and clearly reference these in a list on the last page. References are the sources that you got evidence from, for example a scientific paper or a website
Presentation & Communication	7. Prepare a well structured report or poster, written clearly, concisely and persuasively
Creativity	8. Present original ideas using evidence from your research including original graphs, tables and diagrams where appropriate (these can be produced by computer or hand)

Referencing Guide

What is it?

'Referencing' means acknowledging sources of information that you have used in your work. It is an important part of scientific writing and must be included in any research that is published. By including references in your work, you will:

- Provide clear links between your claims and the evidence backing them up
- Make sure credit is given to fellow scientists for their important work
- Allow your readers to easily follow the development of ideas over time in your scientific field

How do I do it?

Whenever you mention someone else's work (such as information) in your writing, you should include a reference to the original 'source'. Some examples of sources are:

- Articles
- Books
- Websites
- Videos

The minimum your team needs to do is include a list of websites, textbooks, and any other sources you have gathered information from.

See 'Minimum Referencing Requirements' below for more guidance. If you want to earn extra marks for referencing, check out 'Advanced referencing'

Minimum Referencing Requirements

Use the following three steps to help you list where you got your information from. **All entries must follow this guidance!**

1. **Identify the information.** This could be from a website, textbook or documentary
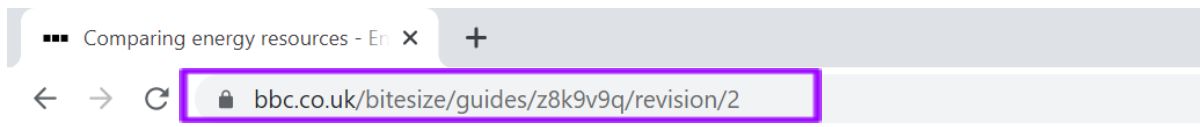
2. **Rewrite the information in your own words.** This means you don't copy exactly what the website/textbook said, but you still use the information.

    "In 2015, 30% of electricity in the UK was produced by burning natural gas."

3. **Put the source in a reference list.** The source could be a website link, or the title of a textbook/documentary. Reference lists should be at the end of your poster or report.
In this example, you can see that the link in the reference list matches the link on the website where the information was found.
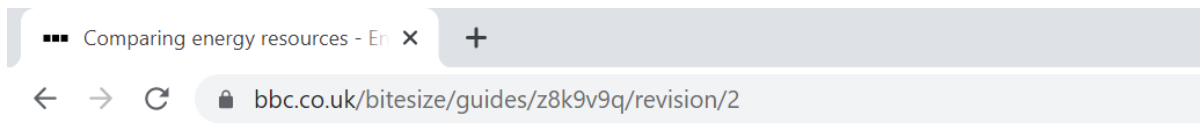
Advanced Referencing

If you want to earn **extra marks for referencing**, check out the rest of this guide. This is much closer to how scientists reference!

1. **Identify the information.** This could be from a website, textbook or documentary.

2. **Rewrite the information in your own words.** This means you don't copy exactly what the website/textbook said, but you still use the information.

   "In 2015, 30% of electricity in the UK was produced by burning natural gas."

3. **Where you have written the information, include square brackets and a number**. Your first piece of information in your poster/report should have '[1]', then your second should have '[2]'.

   "In 2015, 30% of electricity in the UK was produced by burning natural gas. [1] *"*

4. **Put the source in a reference list, using the number in the square bracket.** This tells the reader that source number 1 in your reference list is where you found the information above.

   Your source list should contain:
   a. The name of the website/textbook/documentary
   b. A link to the website OR the author of the textbook OR the producer of the documentary/video (e.g. BBC, Channel 4, SkyOne, YouTube Channel's name)
   c. The date you found the information

Reference list:

[1] BBC Bitesize. Comparing Energy Resources. Available at: https://www.bbc.co.uk/bitesize/guides/z8k9v9q/revision/2 [Accessed 22 February 2023]

You may come across different ways of referencing sources in the future. These are called referencing styles. The referencing style shown above is called Vancouver.

Clear and comprehensive referencing will make your work stand out to the judges!

Further Referencing Examples

Here is another referencing example if you are struggling. Remember, referencing is a skill to learn - don't worry if you don't get it right the first time!

Suppose that I am writing a STEM challenge report. In my report, I make the claim that:

"Agriculture contributed 0.52% to the UK economy in 2021 [1]."

The number in the square brackets tells my reader that, if they want to see the source supporting my claim, they should look at the first entry in my reference list.

Do this for yourself – take a look at my reference list at the end of this document!

Later in my report, I claim that **"aeroponic towers can be used to grow crops through winter [2]".** This time my reader knows that the relevant source is the second entry in my reference list.

Make sure you include a reference list in your own STEM challenge report or poster. Clear and comprehensive referencing will make your work stand out to the judges!

Reference List

[1] 'Total Income from Farming in the United Kingdom' Defra, 2021. Accessed 18th February 2023
https://www.gov.uk/government/statistics/total-income-from-farming-in-the-uk.

[2] 'Sustainable agriculture: urban farmer Will grows food with aeroponic towers', YouTube, uploaded by Defra, 2021. Accessed 20th February 2023.
https://www.youtube.com/watch?v=DHkbyOmXA4Q (5:53).

Success Statements

What makes a good entry?

1. Problem solving

➔ Introduce your chosen problem statement, and explain why the Government needs to address this problem.

➔ Present three possible solutions and explain how each of these will help to solve your chosen problem.

2. Evaluation

➔ Evaluate your three solutions - what are the pros and cons? How effective would they be at tackling the problem?

➔ Compare the practicality of your solutions - would it be expensive? Would it be difficult for the Government to do?

➔ Consider any uncertainties and what other research may need to be carried out to address these.

3. Scientific evidence

➔ Selectively use relevant information from reliable sources, recognising bias where present.

> Wikipedia isn't a reliable source! Choose websites where you can trust the information (such as BBC BiteSize)

➔ Present evidence from a wide range of sources and clearly reference all sources of information.

> See our referencing guide for help on how to do this!

4. Presentation & communication

➔ Prepare a well-structured worksheet, written clearly, concisely, and persuasively.

5. Creativity

➔ Present own ideas and interpretations using evidence from research. This also includes producing original graphs, tables and diagrams to display information.

Privacy Notice

Entries must **NOT** include any **personal information**, such as your names, to ensure anonymity in the judging process is maintained. School names are permitted in entry titles as we will anonymise these before the judging process begins.