UK CanSat Competition Guidelines 2023-24

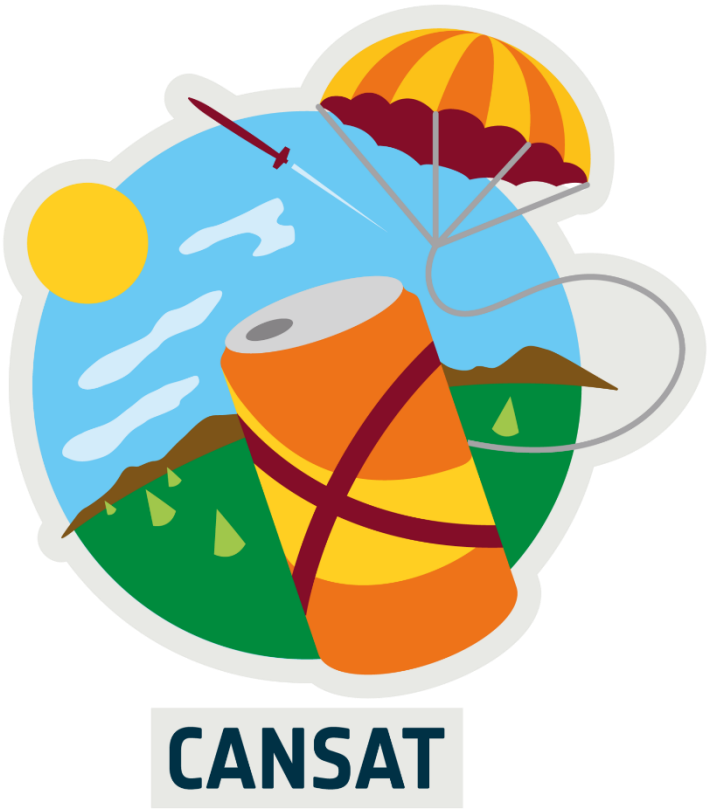

TABLE OF CONTENTS

INTRODUCTION **3**

COMPETITION OVERVIEW **4**

TIMELINE **4**

PHASE 1 - CALL FOR REGISTRATIONS 4
PHASE 2 - TEACHERS' INTRODUCTORY WORKSHOP 5
PHASE 3 - CANSAT CONSTRUCTION AND TEST ACTIVITIES 5
PHASE 4 - REGIONAL LAUNCH CAMPAIGN 8
PHASE 5 - NATIONAL FINAL LAUNCH CAMPAIGN 10
PHASE 6 – LEARNING AND CELEBRATION EVENT 13

FINANCE **14**

CONTACT US **14**

FURTHER SUPPORT **15**

ANNEX 1 – REPORTING **18**

1 INTRODUCTION **20**

1.1 TEAM ORGANISATION AND ROLES 20
1.2 MISSION OVERVIEW 20
1.2.1 Mission Objectives *20*
1.2.2 What will you measure, why and how? *20*

2 PROJECT PLANNING **20**

2.1 TIME SCHEDULE 20
2.2 TEAM AND EXTERNAL SUPPORT 20
2.3 RISK ANALYSIS 21

3 CANSAT DESIGN **21**

3.1 MECHANICAL DESIGN 21
3.2 ELECTRICAL DESIGN 21
3.3 SOFTWARE DESIGN 21
3.4 LANDING AND RECOVERY SYSTEM 21
3.5 GROUND SUPPORT EQUIPMENT 21
3.6 TESTING 22
3.7 OVERALL TESTING FOR LAUNCH 22

4 OUTREACH PROGRAMME **22**

5.1 LAUNCH CHECKLIST/COUNTDOWN 22
5.2 POST MISSION CHECKLIST 22
5.3 LAUNCH DAY RISK LOG 22
5.3 RESULTS ANALYSIS PROCEDURE 22

6 LESSONS LEARNED* **22**

INTRODUCTION

The European Space Agency (ESA) endorses and supports a range of CanSat activities across its Member States (including Canada, Slovenia and Malta), all leading to a European final event – the ESA Space Engineer for a Day learning and celebration event at ESTEC. The CanSat project, aimed at secondary school students, mainly addresses Technology, Physics, and Programming. By offering the practical experience of working on a small-scale space project, CanSat makes use of these subjects in an interdisciplinary manner and promotes collaboration and teamwork.

The UK's European Space Education Resources Office (ESERO-UK) organises the UK CanSat Competition. The winner of the UK competition is invited to attend the 'Space Engineer for a Day' learning and celebration event with the other winning national teams, hosted by the European Space Agency at their ESTEC site in the Netherlands, 20-22 June 2024.

What is a CanSat?

A CanSat is a simulation of a real satellite, integrated within the volume and shape of a soft drink can. The challenge for the students is to fit the major subsystems found in a satellite (such as power, sensors and a communication system) into this minimal volume. In the UK competition the CanSat is launched to an altitude of 300-400 metres by rocket to carry out scientific experiments designed by the students, parachuting back to Earth to achieve a safe landing.

Educational value of the CanSat project

CanSats offer a unique opportunity for students to have a practical experience of a real space project. They are responsible for all aspects of the project: selecting the mission objectives, designing the CanSat, integrating the components, testing, preparing for launch and then analysing and reporting the data. Throughout this process the students:

- learn by doing
- get acquainted with the inquiry-based methodology that is typical of real-life scientific and technical professions
- acquire and/or reinforce fundamental Technology, Physics, and Programming
- understand the importance of coordination and teamwork
- enhance their communication skills.

COMPETITION OVERVIEW

The UK CanSat Competition consists of five phases:

Phase 1 - Call for registrations
Phase 2 - Teachers' introductory workshops
Phase 3 - CanSat construction and test activities
Phase 4 - Regional launch campaign
Phase 5 - National final launch campaign
Phase 6 – European CanSat Space Engineer for a Day learning and celebration event

TIMELINE

Phase 1: Call for registrations	
Activity	**Deadline**
Expressions of interest process opens	May-June 2023
Deadline for expressions of interest	17 October 2023
Phase 2: Teachers' introductory workshop	
Activity	**Deadline**
Teachers' introductory workshops	July, September - October 2023
Phase 3: CanSat construction and test activities	
Activity	**Deadline**
Preliminary Design Review	08 December 2023
Preliminary Design Review Feedback	w/c 08 January 2024
Critical Design Review	19 February 2024
Critical Design Review Feedback	w/c 11 March 2024
Final Design Review	15 April 2024
Phase 4: Regional launch campaign and post-flight activities	
Activity	**Deadline**
Regional launch campaigns	March 2024
Phase 5: National final launch campaign and post-flight activities	
Activity	**Deadline**
National final launch campaign	April 2024
Phase 6: Learning and Celebration Event	
Activity	**Deadline**
National Winners Communicated to ESA	15 May 2024
Space Engineer for a Day Learning and Celebration	June 2024

Phase 1 - Call for registrations

An announcement of opportunity is published on the ESERO-UK website here, with information about the competition and how to register a team.

Eligibility

- each team must comprise of between 3 and 6 students, assisted by a teacher or tutor
- multiple teams can be registered from a school/college
- students must be aged 14 or over
- the team members must be enrolled as full-time students
- at least 50% of the students included in a team must be nationals of an ESA Member State or Associate State (a full list of Member States & Associate States can be found here)
- a completed registration form must be submitted to ESERO-UK by 17 October 2023 for each team taking part. Applications can be made via the link on the webpage here

Responsibility for leading the team

Each team should have a teacher or a tutor responsible for monitoring the team's technical progress, available to offer help and advice, and acting as the point-of-contact between the organisers and the student team. The teacher/tutor is highly encouraged to attend an introductory workshop (if they have not already done so) and they, or a suitable alternative approved by the organisers, must accompany the team to the competition launch campaign.

It is recommended that the team have a mentor within a university or industry to assist in their project. ESERO-UK can help teams to find a mentor through the STEM Ambassador Programme.

Phase 2 - Teachers' introductory workshop

Before students start work on their projects 2-day teacher workshops will be held to introduce the CanSat concept, demonstrate how the hardware and software works and give teachers the opportunity to build their own CanSat. These workshops will take place in July, September and October 2023. More information about these workshops will be

Teacher workshops will consist of:

Day 1: Python programming constructs and Raspberry Pi Pico training

Day 2: An overview of the CanSat competition and the chance to build your own basic CanSat kit. On this day you will be provided with all the skills and tools necessary to build and program a CanSat and carry out the primary mission objectives. You will work in teams to transmit data to one another and come away with the confidence to lead your team through their own CanSat project.

Phase 3 - CanSat construction and test activities

Under the supervision of their teacher/mentor, all the teams participating in CanSat will carry out technical work on their CanSats, applying the procedures used in the typical lifecycle of a real space project, which are:

- selection of mission objectives

- definition of requirements
- design of hardware and software
- one or more reviews of the design (leading to design refinement)
- integration and testing
- launch and operations
- data analysis and reporting of results

CanSat kits

For the 2023-24 competition, a limited number of basic CanSat starter kits will be available free of charge, further information on how to obtain a kit will be communicated once registration closes. These kits are valued at £50 and this must be accounted for in the team's financial record. Kits must be returned to ESERO-UK if the school decides not to enter the competition. There is no requirement to use these kits and other kits or individual components can be used at the expense of the team/school.

Kits will include:

- Microcontroller: Raspberry Pi Pico
- Adafruit BMP280 I2C/SPI Barometric Pressure, Temperature and Altitude Sensor (suitable for gathering all the data needed in the primary mission)
- RFM96W LoRa 433MHz (Transmitter)
- USB Cable
- Half size Breadboard (for prototyping)
- Protoboard (for prototyping)
- Header sets (suitable for the microcontroller and other breakout boards)

To request a kit once you have had confirmation that you have a place in the competition please email esero-uk@stem.org.uk.

Additional hardware will need to be purchased to meet the requirements of the secondary mission (see below). Teams are advised to research suitable options for their CanSat housing and access to a soldering iron will be beneficial.

Primary and secondary CanSat missions

Primary mission

The team must build a CanSat and program it to accomplish the following compulsory primary mission:

After release and during descent, the CanSat shall measure the following parameters and transmit the data as telemetry once every second to the ground station:
• Air temperature
• Air pressure

It must be possible for the team to analyse the data obtained (for example, make a calculation of altitude) and display it in graphs (for example, altitude vs. time and temperature vs. altitude).

Secondary mission

The secondary mission must be selected by the team. It can be based on other satellite missions, a perceived need for scientific data for a specific project, a technology demonstration for a student-designed component, or any other mission that would fit the CanSat's capabilities.

Teams should brainstorm their own mission objectives, ideas and constraints to try to define their mission. The student teams are free to design a mission of their choice, if they can demonstrate it has some scientific, technological or innovative value. Teams should also keep in mind the limitations and requirements of the CanSat mission and consider the feasibility (both technical and administrative in terms of time and budget) of their chosen mission.

Some **example** secondary missions:

1. **Advanced telemetry**

   After release and during descent, the CanSat measures and transmits additional telemetry to that required for the primary mission, for example:
   - Acceleration
   - GPS location
   - Radiation levels

2. **Telecommand**

   During descent, commands are sent from the ground to the CanSat to perform an action, such as switching a sensor on and off, changing the frequency of measurements, etc.

3. **Targeted landing**

   The CanSat navigates autonomously with a control mechanism such as a parafoil. The objective is for the CanSat to land as close as possible to a fixed target point on the ground after it has been released from the rocket. This mission is an advanced telemetry/telecommand mission - navigation data is exchanged between the CanSat and a ground station throughout the descent.

4. **Landing system**

   For this mission, an alternative safe landing system for the CanSat would be deployed, such as a bespoke parachute or airbag.

5. **Planetary probe**

   The CanSat simulates an exploration flight to a new planet, taking measurements on the ground after landing. Teams should define their exploration mission and identify the parameters necessary to accomplish

CanSat Requirements

The CanSat hardware and missions must be designed to the following requirements and constraints:

1. All the components of the CanSat must fit inside a standard soda can (115 mm height and 66 mm diameter), with the exception of the parachute. An exemption can be made for radio antennas and GPS antennas, which can be mounted externally (on the top or bottom of the can, not on the sides), based on the design

2. The antennas, transducers and other elements of the CanSat cannot extend beyond the can's diameter until it has left the launch vehicle
3. The mass of the CanSat must be between 300 g and 350 g. CanSats that are lighter must take additional ballast with them to reach the 300 g mass limit required
4. Explosives, detonators, pyrotechnics, and flammable or dangerous materials are strictly forbidden. All materials used must be safe for the personnel, the equipment and the environment. Material Safety Data Sheets (MSDS) will be requested in case of doubt
5. The CanSat must be powered by a battery and/or solar panels. It must be possible for the systems to be switched on for three continuous hours
6. The battery must be easily accessible in case it has to be replaced or recharged in the field.
7. The CanSat must have an easily accessible master power switch
8. The CanSat should have a recovery system, such as a parachute, which is able to be reused after launch. It is recommended to use bright coloured fabric, which will facilitate recovery of the CanSat after landing
9. The parachute connection must be able to withstand up to 50N of force. The strength of the parachute must be tested, to give confidence that the system will operate nominally.
10. The descent rate between $8ms^{-1}$ and $11ms^{-1}$ is recommended. For directed landings, this may be reduced to $6ms^{-1}$.
11. The CanSat must be able to withstand an acceleration of up to 20g for rocket launch
12. The recovery of the CanSat is not guaranteed after the launch
13. The total budget of the CanSat should not exceed £400. This does not include ground support equipment, such as laptops, power supplies, antennas. **This includes the cost of the basic boxed kit if provided to your school, which costs £50.**
14. The CanSat must have the function to alter the frequency.

Reporting

We require 3 reports at different times during the competition:

Activity	Deadline
Preliminary Design Review	08 December 2023
Critical Design Review	19 February 2024
Final Design Review	15 April 2024

A template version of the report can be found in **Annex 1**. Feedback will be provided by the CanSat judges on each report submitted.

The Preliminary Design Review and Critical Design Review will be used to select the teams that have qualified for the National final launch campaign. Teams invited to the National final will then submit a Final Design Review ahead of the final. Teams not invited to the National final can still submit a Final Design Review which the judges will review and provide feedback on.

Teams will be notified if they have reached the National Final by the **11 March 2024.**

Phase 4 - Regional launch campaign

The highlight of the competition are the launch campaigns. These events will be held in March 2024.

Regional launch events will comprise of one day at several locations across the UK. Teams should have their **CanSats flight ready upon arrival** at the launch site. There will be time for final launch readiness checks but any integration or test of the CanSat must have been carried out beforehand. The regional launches are not competitive, and every team is encouraged to attend a launch, even if their CanSat is not finished. The only requirement is that it is fit to launch by rocket. The regional launches are not used to choose teams for the National final launch, they are more of an opportunity for all teams to have a go at launching their CanSat. However, if a regional launch is available, it will be a valuable part of the test campaign for a team's CanSat. Please note, there are a limited number of places available at each launch and if a regional event is over-subscribed, ESERO-UK will limit attendance to those teams that have progressed furthest with their CanSat projects.

CanSats will be launched by small rocket to a height of around 300-400m.

On launch days there will be prep area for teams to make last minute adjustments to their CanSats but we ask that as much preparation is done before arrival to ensure that the day runs smoothly and that every team can launch their CanSat.

Rocket launches

Rocket launches are subject to strict legal and safety requirements, which will be investigated well in advance. CanSats will be launched individually on-board the rocket, powered by solid fuel rocket motors. It is expected that there will be around 5-10 minutes of prep time as the rocket is fuelled and loaded for launch between the CanSats being loaded and the rocket sealed and launched. The CanSats must be able to remain operable during this period.

The launch itself will exert around 10G to 20G of acceleration on the CanSats for a short 0.5 to 1.5 second thrust duration, followed by around a 5 to 7 second 'coast' before the rocket reaches between 300 – 400m peak altitude. At peak altitude the CanSats are pushed out of the rocket to begin their descent.

Phase 5 - National final launch campaign

The National final launch campaign takes place at the National STEM Learning Centre, York, and a nearby launch venue. **Teams will be chosen to attend the National final launch based on their Preliminary Design Review and Critical Design Review**. Approximately 10 teams will be selected as finalists. Teams invited to the National final will then submit a Final Design Review ahead of the final.

Teams will be notified if they have reached the National final by approximately the **11 March 2024.**

A typical programme for a launch event is as follows:

Day 1

- final integration and technical inspection of the CanSats

Day 2

- launch and recovery operations
- analysis of the mission data and conclusion of results

Day 3

- student teams present data analysis and results to the jury
- competition prize ceremony

A presentation on the results from the launch is required from each team. The competition winners will then be chosen based on the team's performance throughout the project, as well as the final flight operations and results.

Team presentations

On the final day of the event teams will be asked to present their projects and findings. Teams will present in the order that they launched the previous day. Teams are advised to **prepare the main elements of their presentation in advance of the final**, leaving some placeholders for results and conclusions following the launch itself. There will be time after each presentation for the judges to ask questions to the team. Ideally everybody should contribute during the presentation. As a guide each presentation should try and include:

- team roles
- primary and secondary mission objectives and success criteria
- technical solutions, including problems and how they were solved
- mechanical drawings of the CanSat and functional block diagrams for their electronics
- launch results and analyses with reference back to the mission objectives
- main challenges and highlights
- skills and lessons learned
- summary of outreach

Further information on presentation timing and guidelines will be distributed to finalists but teams should aim for a presentation between 7-10 minutes, followed by approximately 3 minutes of questions.

Evaluation and scoring

Winning teams will be decided on by a judging panel appointed by ESERO-UK, comprised of CanSat experts, education experts, engineers and scientists who will evaluate the teams' performances. The jury members will score the teams during the launch campaign and announce the results from their scoring on the final day of the launch event.

The teams will be evaluated on an ongoing basis, via submitted reports and presentations during the final, with the following items being taken into account:

1. Technical achievement

The Jury will take into account how the teams obtained the results, how reliable and robust the CanSat was, and how the CanSat performed. Innovative aspects of the project will be judged (e.g. the tools selected and the hardware/software used). The aspects evaluated will be:

- mission's technical complexity: The CanSat's technical level, understanding of the technical concepts and the originality of the engineering aspects of the mission
- performance of the Primary mission: The CanSat's technical performance in terms of deployment and data collection for the Primary Mission
- performance of the Secondary mission: The CanSat's technical performance in terms of deployment and data collection for the Secondary Mission.

If the CanSat did not succeed in accomplishing the missions but the team is able to explain the reasons why and suggest improvements, it will be also taken into account positively.

2. Scientific value

The scientific value of the teams' missions and the teams' scientific skills will be evaluated. This includes the scientific relevance of the mission, the quality of the technical reporting (both written and oral) and the team's scientific understanding that will be assessed from the team's ability to analyse and interpret results appropriately.

The aspects evaluated will be:

- scientific relevance: assessment of whether measurements are done with a clear and well-founded scientific purpose, the extent to which the CanSat is used in an original way and if the data collection is appropriate for reaching the objective
- scientific understanding: level of understanding of the scientific principles that underlie the project
- technical reporting: ability to summarise with clarity and provide a readable reporting, the proper labelling of the graphs and use of the correct units and the ability to present scientifically sound data and interpretations during the launch campaign.

3. Professional competencies

The jury will assess how well the team worked together on the assignment, the distribution of tasks, the planning and execution of the project and the team's success in obtaining the necessary funding, support and advice. The aspects evaluated will be:

- teamwork: collaborative effort of the team in order to complete the tasks in the most effective and efficient way
- adaptability: attitude towards continual improvement and ability to adapt to new conditions.
- communication: oral presentation skills, the ability to provide a captivating presentation involving confident speaking skills and a visually appealing presentation.

4. Outreach

The team will be scored on how well the project was communicated to the school and the local community, taking into account any webpages, blogs, presentations, promotional materials, media coverage, etc.

Marking scheme

Technical achievement	35%
Scientific value	35%
Professional competencies	20%
Outreach	10%
TOTAL	**100%**

Prizes

The award scheme is designed to acknowledge teams' strengths in as fair a way as possible. The prizes will be awarded according to the following categories:

- Best CanSat Project: this prize will be awarded to the team with the best overall score
- Highest Technical Achievement: this prize will be awarded to the team with the best score in the 'Technical achievement' field
- Outstanding Science Mission: this prize will be awarded to the team with the best score in the 'Scientific value' field
- Most Professional Team: this prize will be awarded to the team with the best score in the 'Professional competencies' field
- Best Outreach prize: This prize will be awarded to the team with the best score in the 'Outreach' field

The following rules will also apply:

- a team can't receive more than one prize
- the Best CanSat Project prize will always be awarded to the team with the highest overall score
- if a team is ranked the highest in several categories, priority will be given to the highest weighting prizes (Outstanding Science Mission (35%) or Highest Technical Achievement (35%)); in case a team is ranked the highest both in the Scientific value and Technical Achievement fields, the prize awarded will be for the category in which the team has the highest score margin, ahead of the 2nd ranked team in that field

For example, if one team has the best scores in both Technical Achievement (scoring 8.5 out of 10) and Outreach (scoring 9.5). They will then be granted the Highest Technical Achievement prize

because this category has a higher weighting, and the Best Outreach prize will be granted to the second-best score in that field.

In a different scenario, where a team has both the best overall score (scoring 8.5) and the best score in Outreach (scoring 9.5), this team will be awarded the Best CanSat Project prize instead, as this prize needs to be awarded to the best overall score, and the 2nd ranked team in the 'Outreach' field would receive the respective prize.

Phase 6 – Learning and Celebration Event

The team that wins the National UK final will be invited to attend the non-competitive 'Space Engineer for a Day' Learning and Celebration Event at ESTEC alongside the overall winners from other ESA Member States and Associate States taking part. The event takes place over 3 days:

- Thursday 20th June 2024 – Teams arrive, welcome dinner
- Friday 21st June 2024 – Space Engineer for a Day event
- Saturday 22nd June 2024 - Departure

The event aims to celebrate the achievements of the teams and to give teams the experience of the day-to-day life of an engineer working at ESA. Students will be able to explore the facilities (e.g. laboratories), hear from space experts, present their work to a panel of experts, enjoy social and space-themed activities and network with the other winning teams.

There are eligibility conditions for the Space Engineer for a Day event, please ensure that your team meets these conditions when participating in CanSat:

- The team must comprise a minimum of 2 students up to a maximum of 6 students, aged 14-19 years old, resident in an ESA member state (e.g. UK), the team must be:
  - Teams of students enrolled sull-time in a secondary school, or
  - Teams of students who are home schooled. Or
  - Teams of members of a social club enrolled in full-time secondary schools
- At least 50% of the students in the team must be nationals of the participating country (in this case the UK)
- Each team needs to be supervised by one or two teacher(s) or mentor(s). If a second teacher/mentor is needed, justification should be provided to ESA at the point of registering for the event.

For the learning and celebration event, ESA will sponsor the accommodation, meals, and local transportation expenses for up to 6 students and 2 teachers/mentors (if justification is provided for the second teacher/mentor) for each national team, including up to 300 euro per person in travel costs. This includes:

- Accommodation for team members and the teachers/mentors.
- A stipend of 300 euros per person to arrange their international travel and transport from the closest international airport or train station to the accommodation/event location and back.
- Local transport for the duration of the event, excluding local transport included as part of the stipend.
- Meals:
  - Dinner on arrival day
  - Breakfast, lunch and dinner on event day
  - Breakfast on departure day

Teams are responsible for their own travel bookings to/from hometowns and the main airport/train station of the event location.

Please note that the above information on ESA sponsorship is for guidance only, the exact terms of the sponsorship are determined by ESA (not ESERO-UK) and may be subject to change.

FINANCE

This section outlines the expectations as to ownership of costs for the competition. This is for guidance only and does not constitute an agreement between ESERO-UK and any third party.

ESERO-UK will pay for:

- catering and accommodation for the duration of the teachers' workshop (if face to face)
- accommodation and catering for the 3 days of the National final launch campaign for up to two teachers and six students
- the cost of an ESERO-UK CanSat kit made available to teachers

The school or sponsors will pay for:

- transport to and from each event outlined above
- any additional electronic equipment required for the secondary mission or ground support, or the cost of any replacement parts in the CanSat kit.
- any costs of cover for teaching
- any other costs incurred by the team not specified above

Subsidies

Subsidies will be available for **state-maintained** schools and colleges to help cover the costs associated with either a regional launch event or the National final launch event. The value of these subsidies is likely to be £400 to attend a Regional launch event and £400 for attendance of the National final launch campaign.

Note: This amount will vary per team for schools with multiple participating teams

CONTACT US

All questions should be directed to:

Tom Lyons
ESERO-UK, The National STEM Learning Centre
University of York
Heslington
York
YO10 5DD
Tel: +44 1904 328178
Email: esero-uk@stem.org.uk

FURTHER SUPPORT

The National Centre for Computing Education (NCCE)

The NCCE offers teachers support to help teach computing through:

- courses and accreditation - a range of professional development courses, designed to help teach computing. Courses cover key stages 1 to 4 and cater for all levels of knowledge. Choose how and when you want to learn, through face to face, online, or live remote training. **Online courses are free for teachers across the UK**
- subsidies for training - financial support is available to state-funded schools and colleges **across England**, including subsidies to support continuing professional development and curriculum delivery.
- free curriculum teaching resources - resources include lesson plans, slides, activity sheets, homework, and assessments. Each key stage has a teacher guide and curriculum map to help you get started. Built around an innovative progression framework where computing content has been organised into interconnected networks called learning graphs. Content is free and in formats that make it easy to adapt it to meet the needs of learners. **Resources are available for free across the UK**
- community support and more – a network 34 Computing Hubs **across England**, led by schools and colleges with excellence in teaching computing. Hubs support schools and colleges to provide a high-quality computing education to all young people. Your local hub can work with you to identify your computing needs and provide a targeted programme of support to help embed this key subject in your school. Support includes high-quality CPD with generous subsidies; teaching and learning resources; and school-to-school support.

NCCE - courses to support CanSat

Computing courses that may be of interest to teachers guiding a team through the CanSat Competition include:

- Foundation knowledge of computer science for KS3 and GCSE - remote (depending on experience) - for computer science teachers who are new or existing to the subject. This CPD covers the foundation subject knowledge required to teach the computing programme of study
- An Introduction to algorithms, programming and data in computer science - remote - create some simple block-based computer programs and discover how to implement them in the text-based language Python
- Programming 101: An Introduction to Python for Educators - online - explore the basics of Python. Guided by the Raspberry Pi Foundation, you'll learn to code your first program
- Python programming constructs: sequencing, selection & iteration - remote (with follow-on 1-day courses should you wish to go further) - learn how to write code to input, process and

output data, and how to manipulate data stored in variables. Using the building blocks of sequence, selection and iteration you'll begin to understand how programs are constructed to perform a multitude of simple and more complex tasks

- Programming with Python – intensive CPD - over this three day CPD package you'll learn how to program using Python, moving from the basics to working with data and advanced subject knowledge
- Physical computing kit - KS4 Raspberry Pi Pico - short course - explore physical computing using the Raspberry Pi Pico device and how the Teach Computing Curriculum can be used to engage students
- Design and Prototype Embedded Computer Systems - online - discover embedded system design and work your way through the product design lifecycle.

There is no obligation to take any of the above courses to take part in the CanSat Competition. They are highlighted here for teachers taking part who would like to advance or refresh their Computing knowledge.

NCCE – Physical computing trays

The local Computing Hubs within the NCCE network **in England** have the following packaged kits available for loan by schools in their region suitable for KS3 – KS4:

- Micro:bit tray
- Raspberry Pi Pico tray
- Raspberry Pi computer tray

These trays are linked to Physical computing lessons within the Teach Computing Curriculum. More information about the trays and the lessons they link into can be found here. If you would like to loan a tray for your students to practice their skills for the CanSat competition please contact your local Computing Hub. Please note trays and all their components must be returned to the Computing Hub once the loan period is up (usually half a term).

These trays differ to the CanSat kits which are available from ESERO-UK. Kits provided by ESERO-UK do not need to be returned to us unless the school are no longer taking part in the competition and are to be used to build the team's CanSat for launch.

NCCE – Computer Science Accelerator

Computer Science Accelerator (CSA) is a professional development programme for teachers, funded by the Department for Education, leading to a national certificate in computer science subject knowledge. The programme will help develop or refresh subject knowledge up to GCSE, with subsidy funding available for state-funded schools and colleges to support your learning.

There is no obligation to apply for the Computer Science Accelerator programme to take part in the CanSat Competition. It is highlighted here for teachers taking part who would like to advance or refresh their Computing knowledge.

NCCE – Subsidies

The NCCE offers subsidies to state-funded schools **in England** to enable teachers to participate in remote, online and face-to-face CPD. Find out more here: https://teachcomputing.org/funding

Other support and information

- ESA CanSat resources can be found here
- The CanSats in Europe Portal can be found here
- The CanSat in Europe Facebook page can be found here

ANNEX 1 – REPORTING

Instructions

This is a template for the CanSat report – please copy and paste the below template into a separate document and follow it as it is. **Please do not include any personal information such as names or photographs of team members or anybody involved in outreach activities in the reports.**

Preliminary Design Review (PDR)

The first report should include your plans for the project and initial activities. Include high level descriptions, diagrams and basic sketches. Consider what software and hardware could be used to achieve both missions and how feasible they will be to use. Include calculations and identify suitable designs. Show your plans for testing.

Critical Design Review (CDR)

The second report should include evidence of prototypes through photos or CAD sketches. Think about including high level systems diagrams, circuit diagrams, block diagrams etc. Explain what sensors are being used and the justification for using them. Include block and flow diagrams and a high-level description of the design as the software is starting to be put together and tested. A full copy of the code is not required. Include parachute design, calculations used to reach the final decision and information on any prototypes developed. Show evidence of initial tests for each aspect of the CanSat and the decisions made based on them.

Final Design Review (FDR)

The third report should cover the final iteration of the mechanical design, electronics, software, landing and recovery system and ground support system of the CanSat. If changes were made include why. Design justifications are important for each sketch or CAD rendering etc. Include all finalised tests and decisions made based on them. Results could be displayed in a table of tests and results, and there must be verification against the CanSat requirements (found on page 8 of the competition guidelines).

For the FDR we have included sections on the launch day and lessons learned to be included. Teams invited to the final should also start to prepare a 7-8 minute presentation that will include aspects of this report but also a placeholder for final results from the final launch day – this will be presented on the day after the launch.

Page limits

Maximum page limits for the reports are:

Preliminary Design Review - 20 pages (plus unlimited appendices)
Critical Design Review - 25 pages (plus unlimited appendices)
Final Design Review - 30 pages (plus unlimited appendices)

Any pages submitted over these maximum amounts will not be read.

UK CanSat Competition

Team Name

School

Preliminary Design Review

Critical Design Review

Final Design Review

(delete as applicable)

Date: -------

1 INTRODUCTION

1.1 Team Organisation and Roles

This section should contain a simple list of the assigned roles and responsibilities (e.g. Project Manager, Parachute Engineer, Outreach Lead etc.). ***It must be anonymous and not include any personal data such as names or photographs.***

1.2 Mission Overview

1.2.1 Mission Objectives

This part is not a description of the CanSat, it is only a summary of the main goals that your CanSat will achieve, and a sentence on what these goals achieve with relation to scientific/engineering objectives.

Primary Mission:

This part should contain a list of primary objectives of your mission – such as given in CanSat requirements.

Secondary Mission:

This part should contain a concise list/description of the secondary mission you are planning to achieve.

1.2.2 What will you measure, why and how?

Concise description of what measurements your CanSat will make, why you will take these measurements and what sensing capabilities will be required. Include some thought on how will you analyse the data.

2 PROJECT PLANNING

2.1 Time schedule

A detailed project time plan which shows the tasks required to complete the project and the time (suggested to be hours required) allocated to each step. This should cover all scientific, technical and outreach tasks that need to be done and is updated with each report. A Gantt chart may be used to display this project planning. This must be at least a high-level weekly plan.

2.2 Team and External Support

Your team is your most vital resource. You must be aware of your competencies and be able to identify where you may need to expand the team or ask for external support. Please describe the tools and support available to you and what external support you are planning to get. Please

identify, based on your team skills, what support you may need. In any project it is important to seek external help and support.

2.3 Risk Analysis

What could go wrong for the project? Think about the team, time constraints, equipment or technical issues. This will change as the project develops.

3 CANSAT DESIGN

Please complete all the following sections. The information provided can change between each report as the CanSat is tested and changes are made to the design.

3.1 Mechanical design

For the PDR this should contain a high-level description, a sketch or sketches of the CanSat and information on the identification of potential suitable materials and their justification. In the CDR include evidence of prototypes such as photos or CAD sketches if this is being used. The FDR should cover the final iteration of the mechanical design. If changes were made include why. Design justifications are important for each sketch or CAD rendering etc.

3.2 Electrical design

For the PDR consider which processor or microcontroller will be used and include initial plans for which sensors will be used. For the CDR please include high level systems diagrams, circuit diagrams, block diagrams etc. Include which sensors are being used and the justification for this. The FDR should cover the final iteration of the electrical design. If changes were made include why.

3.3 Software design

For the PDR think about what software is needed and how feasible it is to use. Identify what software modules are going to be needed to be developed and perhaps include high level flow diagrams. For the CDR include block and flow diagrams and a high-level description of the design as the software is starting to be put together and tested. A full copy of the code is not required. The FDR should cover the final iteration of the software design. If changes were made include why.

3.4 Landing and recovery system

For the PDR include some calculations and identification of suitable designs. Include basic sketches. For the CDR include the final parachute design and the calculations used to reach the final decision. The FDR should cover the final iteration of the landing and recovery system. If changes were made include why. This section should be more in-depth if the mission includes special landing gear or separating parts.

3.5 Ground support equipment

For the PDR identify what equipment will be needed. This includes laptops, Yagi antennas or any other equipment that you need on the ground to support the launch. For the CDR include information on any prototypes developed. The FDR should cover the final iteration of the ground support equipment. If changes were made include why.

3.6 Testing

For the PDR include a test plan. For the CDR show evidence of initial tests for each aspect of the CanSat and the decisions made based on them. For the FDR include all finalised tests and decisions made based on them. Results could be displayed in a table of tests and results, and there must be verification against the CanSat requirements found on page 8 of the competition guidelines.

3.7 Overall testing for launch

A brief description of tests carried out to plan for a launch. How can you best simulate the conditions for your launch?

4 OUTREACH PROGRAMME

Consider all types of media to promote and disseminate information about your project. For the PDR include an outreach plan or schedule and consider the target age/demographic. For CDR include details of outreach done and justifications of the approach taken.

5 LAUNCH DAY PREPERATION*

5.1 Launch checklist/countdown

An ordered list of tasks with times, durations and team members responsible that you shall follow on the launch day to setup your CanSat and ground support equipment ready for launch.

5.2 Post mission checklist

An ordered list of tasks with times, durations and team members responsible that you shall follow once your can is back on the ground. Might be as simple as "1. save data 2. turn can off".

5.3 Launch Day risk log

(Think about what could go wrong on launch day and how the risks could be mitigated)

5.3 Results analysis procedure

Description of procedure of how you are to interpret and use your sensor data for use in your presentation. Include details of any calculations used and how this analysis relates to your primary/secondary mission objectives. How will you determine if your measured data is valid and what is your criteria for a successful mission?

6 LESSONS LEARNED*

Reflect on your participation in the competition. What have you learnt from the process? Has this changed anything for you in terms of subject or career decisions? What has been the most challenging part? What has been the best part?

*Only required for final report