GUIDELINES

Dutch CanSat Competition 2018-2019

The Netherlands esero

INTRODUCTION

Turn a soft drink can (Can) into a satellite (Sat) with a mission. That is the CanSat Competition assignment. CanSat is an ESERO project being implemented by NEMO on behalf of the Netherlands Space Office (NSO). The competition has been set up to encourage secondary school students to follow a technical training course. The CanSat Competition, which targets secondary school students, is aimed at addressing technology, physics and programming curricular subjects. The CanSat activity provides the students with practical experience of a small-scale space project and promotes teamwork.

What is a CanSat?

During the CanSat competition, teams consisting of four to six pupils from 4th to 6th grade of havo and vwo design and build a CanSat. A CanSat is a simulation of a real satellite, integrated within the volume and shape of a soft drinks can. The challenge for the students is to fit all the major subsystems found in a satellite, such as power, sensors and a communication system, into this minimal volume. The teams devise a mission, draw up a research proposal, and design, build and test a satellite. The CanSat is then launched to an altitude of about one kilometre by a rocket and its mission begins: to carry out a scientific experiment, achieve a safe landing and analyse the data collected. During the flight, radio contact is maintained with the ground station to transmit telemetry and other signals. The pupils work together and gain experience in building a complex system in which various disciplines play a role.

All elements of a real space flight project are involved during the competition. Examples include drawing up a mission proposal, system design, documentation, programming, building and testing the system and the launch, but also the communication via social media and the press. The multi-disciplinary character of the competition means that the teams can be made up of a wide range of participants with various interests. The participants will be introduced to working in a team, which is a vital skill with a view to their studies and a professional career.

And last but not least, the winning team will participate in the European CanSat Competition, organised by ESA. See www.cansat.eu/.

Educational value of the CanSat competition

The CanSat competition provides the participating teams with the opportunity to experience all the phases typical of a real space project, from selecting the mission objectives, designing the CanSat, integrating the components, testing the system, preparing for launch and then analysing the scientific data obtained. Through this process the students:

- learn by doing;
- become acquainted with the enquiry-based methodology typical of real-life scientific and technical work;
- acquire and/or reinforce fundamental technology, physics and programming curricular concepts;
- understand the importance of coordination and teamwork; and
- enhance their communication skills.

COMPETITION OVERVIEW

Call

To participate in the CanSat Competition, you will have to submit a research proposal. The call for proposals is published on the CanSat website www.ruimtevaartindeklas.nl/cansat. The deadline for proposals is **3 p.m. on Thursday 11 October 2018**. The team leader must e-mail the Team Portfolio (to be downloaded from the website) together with the completed proposal form and a signed photography & filming consent form per team member and teacher before the deadline to info@ruimtevaartindeklas.nl. Please use the subject line: "2018 - 2019 CanSat Competition Proposal".

Responsibility for leading the team

Each team must have a teacher (team leader) responsible for monitoring the team's technical progress, who is available to offer help and advice and who acts as the point of contact between the organisers of the competition and the team. The team leader must be available to accompany the team to the test and launch events.

Preparation CanSat Competition

Between 1 September and 11 October 2018, under the supervision of the team leader, the teams will work on the design of their CanSat project, applying the procedures used in the typical lifecycle of a real space project, which are:

- selection of mission objectives;
- definition of technical requirements necessary to achieve these objectives; and
- design of hardware and software.

All this will be laid down in the research proposal and submitted to the organisers of the CanSat Competition.

Eligibility and team selection

The following conditions should be fulfilled in order for a proposal to be considered as eligible:

- The team should comprise between four and maximum of six (aged 14-20) full-time secondary school students, assisted by a teacher.
- A complete research proposal must be submitted before **3 p.m. on Thursday 11 October 2018**.
- The research proposal is written in English.
- A signed photography & filming consent form *per team member (and teacher).*

A maximum of 50 teams will be admitted to the competition. The teams will be selected based on the quality of the research proposal and technical feasibility. A maximum of two teams per school can participate in the competition.

Once your proposal has been submitted and evaluated, you will receive a confirmation of your team's entry. The confirmation will include an invitation for the team leader to attend the teachers' workshop in November. The selected teams for the competition will be announced[1] no later than 29 October. All selected teams will then receive a CanSat starter kit. This kit contains all elements needed to assemble a working CanSat, including the primary mission.

[1] The result will be final.

Teacher Workshop

When the team is admitted to the competition, the team leader (teacher) will have the opportunity to attend the teacher workshop at NEMO Science Museum in Amsterdam on Saturday 10 November, where they will learn the basics of building a CanSat:

- working with the Arduino platform;
- soldering;
- programming; and
- radio communication.

Overview of the competition timeline

After receiving the CanSat kit, the teams can start their CanSat project. The CanSat Book, which can be downloaded from the website, will provide the teams with the basic information required to start their CanSat project.

The CanSat Competition has the following structure:

1 September 2018	Call for proposals online
11 October 2018	Research proposals submission deadline
29 October 2018	Team selection announcement
10 November 2018	Teacher workshop
9 January 2019	Progress report deadline
23 January 2019	CanSat Test Day (back-up date: 30 January)*
17 February 2019	Final design deadline
4 March 2019	Announcing team selection Launch Event
22 March 2019	CanSat Launch Event (back-up date: 29 March)*
9 April 2019	Final report deadline
16 April 2019	Award Ceremony*
23 – 28 June 2019	European Competition

*Please note that the dates for the test day and launch event are the preferred dates and have yet to be confirmed. The exact dates and any changes will be communicated to the team leaders and announced on the website www.ruimtevaartindeklas.nl/cansat. In the case of bad weather, there will be a back-up date for the test day and launch event.

Reporting – Team Portfolio

In order to monitor the progress of each team, two reports have to be submitted during the competition: the Progress Report and Final Design. For the research proposal, the progress report and the final design report, you will use the same document, which will be your Team Portfolio. This portfolio contains templates for all three reports. The first section, the Research Proposal form, will be completed when applying for the CanSat Competition. When you wish to submit your Progress Report, you will use the same document you submitted for application and complete the next section with the Progress Report form. You will complete your portfolio in the same way by adding the last section for the Final Design report. The CanSat Team Portfolio with reporting templates can be found on the CanSat website www.ruimtevaartindeklas.nl/cansat.

Progress Report

The function of the progress report is to provide the organisers with a status update on your CanSat project and mission in preparation for the CanSat test day and ultimately the CanSat launch event. The Progress

Report will be an amended version of the research proposal and will include all the discrepancies from the proposal and an assessment of the progress of technical performance measures.

The CanSat Progress Report must contain:

- a demonstration showing that all the technical and other requirements stated in the guidelines have been met, or at least the ones that are required for the CanSat test day;
- the design specifications in order to meet the secondary mission;
- any adjustments to the original design plan as stated in the proposal;
- the results of requirements verification tests;
- the revised budget; and
- the revised outline of the project schedule.

Based on their Progress Report, the teams will receive feedback on the technical aspects of their CanSat project to prepare them for the CanSat test day.

The deadline for submitting the Progress Report is **3 p.m. on Wednesday 9 January 2019**. The Team Portfolio together with the completed Progress Report must be e-mailed before the deadline to info@ruimtevaartindeklas.nl. Please use the subject line: “CanSat Progress Report [team name]”

Final Design review

The Final Design is the final report that should be submitted before the launch. This report will contain all the alterations made to the CanSat design and summarises all the work performed to date. This document should accurately record all the details of the completed CanSat prototype and provide a full description of the CanSat system and its functionalities. Based on the Final Design, the work and performance of each team will be reviewed. On the basis of the Final Design reviews, the organisers of the CanSat competition will select the best ten to fourteen teams who will have the opportunity to launch their CanSat with the CanSat rocket at the CanSat launch event.

The deadline for submitting the Final Design is **Sunday 17 February 2019**. The Team Portfolio together with the completed Final Design must be e-mailed before the deadline to info@ruimtevaartindeklas.nl. Please use the subject line: “CanSat Final Design [team name]”

CanSat test day

On 23 January 2019, a test day will be organised. The teams will have the opportunity to launch their CanSat with a drone and to check whether all systems are working. The teams will then be allowed to make final changes to their design. The test day is not compulsory, although attendance is highly recommended as testing is an important part of the CanSat design process.

Because of a maximum of 10 to 14 launch slots during the launch event in March, the test day – in the case of more teams competing – will also serve as an opportunity for all participants to launch their CanSat at least once.

Please note: The CanSat test day will ***not*** be part of any assessment or review of team performance. However, it is important to state in your Final Design how you tested your CanSat design and how you used the test results.

The test day will be organised on 23 January 2019. In the case of bad weather, there will be a back-up date for the test day on 30 January 2019. Therefore save both dates in your agenda. Both dates for the test day have yet to be confirmed. The exact dates and any changes will be communicated to the team leaders and announced on the website www.ruimtevaartindeklas.nl/cansat.

CanSat launch event

The highlight of the competition will be the launch event, scheduled for 22 March 2019, at which the CanSats will be launched in a rocket up to an altitude of approximately 1 km. The CanSats will then separate from the rocket, conduct their missions, and land safely on the ground to be recovered by the hosts of the event. The CanSats must be flight-ready upon arrival at the launch event.

In the case of bad weather, there will be a back-up date for the launch event on 29 March 2019. Please note that both dates for the launch event have yet to be confirmed. The exact dates and any changes will be communicated to the team leaders and announced on the website www.ruimtevaartindeklas.nl/cansat.

Team selection

On the launch day, no more than 10 to 14 launch slots will be available. If there are more competing teams than there are launch slots available, a selection will be made. The organisers will consider all Final Designs on the basis of their scientific merit, team organisation and outreach plans. The final selection will be communicated to the team leaders on Monday 4 March 2019.

Post-flight activities

Final report and award ceremony

After the launch event, the teams will be requested to submit the CanSat Final report, which contains the *Final paper* and the *CanSat log*. The Final paper follows the standards of a scientific paper including an abstract and a manuscript of the project. The CanSat log describes your CanSat project's process and outreach activities. The deadline for submitting the Final report is **3 p.m. on Tuesday 9 April**. The Final report (template to be downloaded from the website) must be e-mailed before the deadline to info@ruimtevaartindeklas.nl.

At the award ceremony (**Tuesday 16 April** at NEMO Science Museum, Amsterdam), each team will present their CanSat project. A jury in charge of evaluating the teams and their work will be nominated by the organisers. The jury will select the winning teams based on the presentations and the Final report.

European Competition

The winner of the Dutch CanSat Competition will be automatically entered as a participant for the European Competition, organised by ESA. Information on the European Competition and the European Competition Guidelines from ESA can be downloaded here: www.esa.int/Education/CanSat/

For the European competition launch campaign, ESA will sponsor the accommodation, meals and local transport expenses for one teacher and a maximum of six students per national team, as well as all costs for the rocket launches and related flight activities.

All teams will be responsible for their travel arrangements and expenses from their hometowns to and from the main airport/railway station to the launch campaign location and for the costs of their CanSat hardware and tools.

MISSION OVERVIEW

The CanSat competition is designed to simulate all aspects of a real satellite mission, including design, development, testing, launch, operations and data analysis.

The rocket launch

The launch campaign will be organised in cooperation with DARE. The rockets used will be the CanSat Launcher V7. Each rocket can host five to seven CanSats with the following characteristics:

apogee: approximately 900 to 1,000 m

flight time: maximum 90 s

The rocket will deploy its parachute at apogee, reached at around 12 to 13 seconds after take-off, together with the CanSats. Just after the apogee (0 to 2 seconds later), the CanSats will separate from the rocket and will descend on separate parachutes. The CanSats are usually found within 1 km of the launch site. However, recovery cannot be guaranteed. During the flight, the rocket can reach a maximum acceleration of 10 G in the vertical direction and a maximum velocity of 550 km/h.

Primary and secondary CanSat missions

Primary mission

The team must build a CanSat and program it to accomplish the compulsory primary mission as follows. After release and during descent, the CanSat must measure the following parameters and transmit the data as telemetry at least once every second to the ground station:

- air temperature; and
- air pressure.

It must be possible for the team to analyse the data obtained (e.g. make an altitude calculation) and display it on graphs (e.g. altitude versus time and temperature versus altitude). This analysis can be performed in a post-flight analysis.

Secondary mission

The secondary mission for the CanSat 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. Some examples of missions are listed below, but teams are free to design a mission of their choice, as long as it can be demonstrated to have some scientific, technological or innovative value and as long as it fits the technical and other requirements. Teams should also take account of the limitations of the CanSat mission profile and focus on the technical and administrative feasibility of their chosen mission.

Secondary mission examples include:

1. Advanced telemetry
   After release and during descent, the CanSat measures and transmits additional telemetry for the primary mission, for example:

   - acceleration;
   - GPS location; and
   - 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 wing or an airbag.

5. Planetary probe
   A CanSat can simulate 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 it (e.g. pressure, temperature, samples of the terrain, humidity, etc.).

Outreach programme

During the competition, each team's efforts will be judged on scientific relevance, technical achievements and innovative aspects. But a successful CanSat project relies not only on technical skills! Teamwork skills and outreach, such as social and other media coverage, are also important aspects of a space project and will therefore be assessed too.

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 soft drinks 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. NB: The rocket payload area has a maximum of 4.5 cm of space available per CanSat, along the can's axial dimension (i.e. height), which must accommodate all external elements including the parachute, parachute attachment hardware and any antennas.
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 grams and 350 grams. CanSats that are lighter must take additional ballast with them to reach the 300 grams minimum 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 parachute connection must be able to withstand up to 1,000 N of force. The strength of the parachute must be tested to ensure that the system will operate normally.
6. For safety reasons, a maximum flight time of 90 seconds is mandatory. This is the total flight time including lift-off to 1 km. This means the CanSat should descend from 1 km to the ground in 70 seconds. This maximum flight time also applies if attempting a directed landing. If your CanSat design does not meet this criterion, you cannot launch your CanSat.
7. The maximum flight time implies an average minimum descent rate of 13 m/s, which is recommended for safety and recovery reasons.
8. The total budget of the final CanSat model should not exceed €500. Ground stations and any related non-flying items will not be considered in the budget.
9. In the case of sponsorship, all the items obtained should be specified in the budget with the corresponding current market costs.
10. The CanSat must be flight-ready upon arrival at the launch event. A final technical inspection of the CanSats will be carried out by authorised personnel before launch.
11. The CanSat must be powered by a battery and/or solar panels.
12. The CanSat must have an easily accessible master power switch.

If your CanSat does not meet these criteria, you will not be selected for the launch event and you cannot launch your CanSat. Therefore, you should be able to demonstrate in you Final Design report what methods you have used to test your CanSat on these criteria.

Other recommendations for a successful CanSat launch and retrieval:

13. The systems must be able to be activated for four hours non-stop without the battery running low.
14. The battery must be easily accessible if it has to be replaced/recharged.
15. Inclusion of a retrieval system (beeper, radio beacon, GPS, etc.) is recommended.
16. The CanSat should have a recovery system, such as a parachute capable of being reused after launch. Bright coloured fabric is recommended.
17. The CanSat must be able to withstand an acceleration of up to 20 G.

EVALUATION AND SCORING

The teams' efforts will be evaluated with the following items being taken into account:

Educational value

For this item, the jury will consider the quality of the Final report, the team presentations, the level of effort made by the team and how much the team appears to have learned throughout the project.

Technical achievement

Innovative aspects of the project will be judged, e.g. the mission selected and the hardware/software used. The way in which the teams obtained the results, as well as the reliability and robustness of the CanSat and its performance will also be taken into account. If the CanSat does not succeed in accomplishing the missions but the team is able to explain the reasons why and suggest improvements, these issues will also be considered positively.

Teamwork

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

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, social media, presentations, promotional materials, media coverage, etc.

Information on the evaluation and scoring system of the European Competition can be found in the European CanSat Competition guidelines.

COSTS

All the events (the teacher workshop, the test day and the launch day) will be completely free of charge, including the CanSat kit for each participating team. This CanSat kit contains all elements needed to assemble a working CanSat, including the primary mission.

Travelling expenses and budget for CanSat development are not included.

CONTACT

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