# The Canadian CanSat Design Challenge 2023-24 Competition Requirements

Prepared by the Canadian Satellite Design Challenge Management Society, with generous support from:

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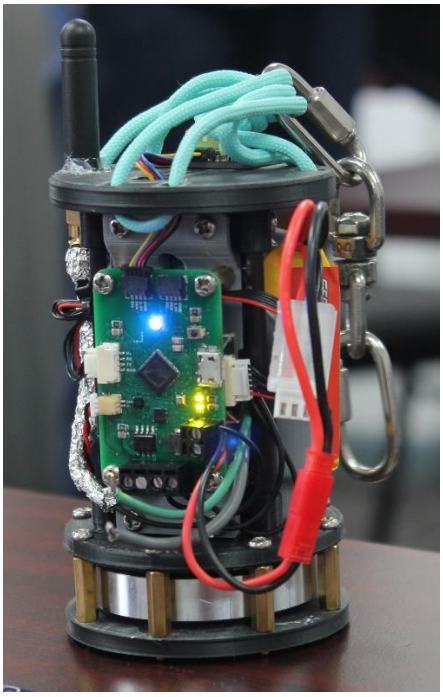
# INTRODUCTION

The Canadian CanSat Design Challenge is an educational initiative which requires teams of secondary-school students to design, build, and launch their own miniature satellite called a "CanSat". A CanSat is a simulation of a real satellite, which is the size of a standard pop can, and weighs between 300 and 350g.

The CanSat contains a small computer, a sensor to record air temperature and pressure, and an additional experiment of the team's choosing. It is then launched by rocket (or dropped by helicopter or drone) up to an altitude of 1km, and as it parachutes to the ground it collects the experiment data which will later be analysed.




**A CanSat is a pop-can-sized "satellite."**

## Participation Categories

Two categories of the competition are offered: **Beginner** and **Advanced**.

In the Beginner category, the CanSat must save the data on an on-board memory card.

In the Advanced category, the CanSat must transmit the data via radio, and be received by the team on the ground.

With these two categories, as well as with tutorials to guide them along the way, secondary-school students of all levels can participate at either level, regardless of prior experience or expertise (or lack thereof).

## The Launch Campaigns

Each category concludes with a Launch Campaign.

For the **Beginner** category, the CanSats can be mailed to the CanSat competition manager (Lawrence Reeves), and they will be dropped from a drone or helicopter. The CanSats will be returned to the teams so that they can analyse the data which their CanSat has collected.

For the **Advanced** category, teams are required to attend the **Advanced Category Launch Campaign**, which will be held in **Alberta**, in mid-May, 2024 (TBC). The participating teams will be required to raise the necessary funding for travel to Calgary International Airport, five nights' accommodation in hotel, and meals (the hotels we have stayed at have had complimentary breakfast. The CSDCMS also provides lunch on the launch day, and the opening and finale dinners).

**Participants at the Advanced Launch Campaign near Lethbridge, Alberta, in April, 2023.**

## CanSat Video Tutorials

The CSDCMS has created a number of publicly-accessible video tutorials on YouTube, located at:

https://www.youtube.com/@CSDCMS

These tutorials guide you through the process of assembling and testing a Beginner category CanSat, from when you receive your CanSat kit, to the final finished product.

# COMPETITION SCHEDULE

These are subject to some changes, but hopefully not many!

| Beginner Category | |
|---|---|
| Information session(s) - via Zoom | Until mid-October, 2023 |
| Registration deadline | October 27, 2023 |
| CanSat kits sent to participating teams | by December 15, 2023 |
| Design! Build! Test! | January to May, 2024 |
| Beginner Category Online Conference | Mid-February, 2024 |
| Launch event (no travel required) | May, 2024 |

| Advanced Category | |
|---|---|
| Information session(s) - via Zoom | Until mid-October, 2023 |
| Registration deadline | October 27, 2023 |
| CanSat kits sent to participating teams | by December 15, 2023 |
| Design! Build! Test! | January to May, 2024 |
| Preliminary Design Document due | February 14, 2023 |
| Pre-Launch Report due | April 27, 2023 |
| Launch event in Alberta | May 9-13, 2024 (TBC) |

# General Rules

## Student & Team Eligibility

Teams in the Beginner category must have at least two students. Teams in the Advanced category must have four to six students. The team members must either be enrolled full-time in a secondary school, or registered for home-schooling per their provincial requirements. The team members are permitted to be from different schools.

The winning team of a previous year's Advanced Category CanSat Design Challenge may not participate in the Advanced category again, with the exception of the teacher/mentor and at most one student from any former winning team.

## Team Supervisor

Each team must have a supervisor, i.e., a teacher or other mentor, who will be responsible for monitoring the team's technical progress, offering help and advice, and acting as the team's point of contact with the CSDC Management.

Teams in the Advanced category who attend the launch event must be accompanied by at least one adult supervisor, and in accordance with any other regulations or policies of their school(s).

## Language of Communication

Written reports and oral presentations must be given in either English or French. Note that for the European Space Agency workshop, the working language is English.

## How to Register

Please complete the Registration form on our website (www.csdcms.ca), under "CanSat Design Challenge".

## There Is No Registration Fee!

There is no registration fee to participate.

## How to Contact Us

The point-of-contact for the CanSat Design Challenge is:

Lawrence Reeves
m: +1 778-988-6343
e: LReeves@csdcms.ca

# Mission & Technical Requirements

The Canadian CanSat Design Challenge evaluation and scoring are based on the ESA CanSat competition; however, the Canadian competition has additional requirements which will be evaluated as defined in this document.

The requirements for both the **Beginner** and **Advanced** categories are almost identical, with explicitly-noted exceptions.

## Primary Mission

Each team's CanSat must accomplish the following compulsory primary mission:

> To measure, after release and during descent, the following parameters at least once per second:
>
> - Air temperature
> - Air pressure
>
> The CanSat must also either:
>
> - store the data on-board on a memory card (Beginner category); or,
> - transmit the data as radio telemetry to a ground station (**Advanced** category).

During the post-flight analysis, 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

Each team must implement a secondary mission of their own choosing.

Teams can take ideas from real satellite missions, or collect scientific data for a specific project, make a technology demonstration for a student-designed component, or any other mission that would fit inside the CanSat and show its capabilities.

Teams should discuss and decide upon their own mission objectives, ideas, and constraints in order to define their mission. Teams are free to design a mission of their choice, as long as they can demonstrate that is 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.

## CanSat Technical Requirements

The following terminology is used for the requirements:

- "must" denotes a requirement which is mandatory;
- "should" denotes a requirement which is optional, but recommended;
- "may" denotes a requirement which is optional.

The CanSat hardware and mission must be designed following these requirements and constraints.

1. All the components of the CanSat must fit inside a standard soft drink can (115 mm height and 66 mm diameter), with the exception of the parachute and parachute connector. Radio antennas and GPS antennas **may** be mounted externally on the top or bottom of the can, depending on the design, but not on the sides.

   *Note: The rocket payload area usually has about 5 cm of space per CanSat available, above the top of the CanSat, which must accommodate all external elements including parachute, parachute attachment hardware, and any antennas.*

2. Elements of the CanSat **must** not extend beyond the can's diameter until it has left the launch vehicle.

3. The mass of the CanSat must be between a minimum of 300 grams and a maximum of 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 inflammable or dangerous materials are strictly forbidden. All materials used must be safe for the personnel, the equipment, and the environment. In case of any concern, Material Safety Data Sheets (MSDS) may be requested from the teams.

5. The CanSat must be powered by a battery and/or solar panels. It must be possible for the systems to remain switched on for two continuous hours.

6. The battery must be easily accessible in case it has to be replaced/recharged.

7. The CanSat must have an easily accessible master power switch. The CanSat **must** also have an "ON" light which **must** be obvious to notice when the CanSat is on.

8. Inclusion of a positioning system for retrieval (beeper, radio beacon, GPS, Apple Tag, etc.) is **highly** recommended.

9. The CanSat should have a recovery system, such as a parachute, capable of being reused after launch. It is **highly** recommended to use bright-coloured fabric (e.g., "high-visibility orange"), which will facilitate recovery of the CanSat after landing.

10. The parachute connection must be able to withstand up to 50 N of force. The strength of the parachute must be tested to ensure that the system will operate nominally.

11. For recovery reasons, the CanSat **should** have a maximum flight time of 120 seconds. If attempting a controlled landing, the CanSat **should** have a maximum flight time of 200 seconds.

12. An un-controlled descent rate between 8 and 11 m/s is recommended for recovery reasons. However, the CanSat's un-controlled descent speed must not be less than 5 m/s or greater than 12 m/s for safety reasons. Additionally, the airfield or weather conditions might determine additional mandatory restrictions on the velocity.

13. ***(Advanced category only):*** The CanSat must be able to withstand an acceleration of up to 20g.

14. The total budget of the final CanSat model should not exceed CAD $800. Ground Stations and any related non-flying item will not be considered in the budget. More information regarding the penalties in case the teams exceed the stated budget can be found in the Evaluation Criteria section. In the case of sponsorship, all sponsored items should be specified in the budget with the actual corresponding costs on the market.

15. ***(Beginner category only):*** The CanSat **must** save all of its experiment data on an SD-card integrated inside the CanSat. The SD-card **should** be easily accessible, or connectable, in order to download the data afterwards.

16. ***(Advanced category only):*** The CanSat must down-link its data by radio. The assigned frequency must be respected by all teams in the Launch Campaign.

    *Note: The allowable frequency in Canada is the 915 MHz range (902 MHz to 928 Mhz). The Reyax RYLR896 is a suggested model which meets this requirement.*

17. The CanSat must be flight-ready upon arrival at the launch campaign.

18. As part of their Educational Outreach efforts, each team must give at least one presentation to each of the following:
    - an elementary school class or group;
    - a junior secondary school audience (Grades 8 to 10); and,
    - a public audience, such as a school "Open House", a teachers' conference, or other adult-level audience.

    *Note: For the Beginner Category this is optional – but still recommended!*

# Evaluation & Scoring – Advanced Category

## The Jury

The Jury will be comprised of CanSat experts, education experts, or engineers and scientists who will evaluate the teams' performances during the Launch Campaign, considering the CanSat Pre-Launch Report. The jury members will score the teams during the launch campaign and announce the results from their scoring in the Closing Ceremony.

## Evaluation Criteria

Performance in the following areas will be evaluated:

### A. Technical Achievement

The Jury will consider 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.

### B. 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 interest: Whether the scientific objectives are of value to the scientific community.
- Scientific adequacy: Whether measurements are done with a clear and well- founded scientific purpose, and if the data collection is appropriate for reaching the objective.
- Scientific understanding: Level of understanding of the scientific principles that underlie the project.

### C. Professional Competencies

The Jury will assess the team's collaboration and coordination, adaptability, and communication skills. 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.
- Technical reporting: Ability to summarise with clarity and provide a readable and complete Pre-Launch Report, the proper labelling of the graphs and use of the correct units and the ability to present scientifically sound data and interpretations.

### D. Educational Outreach

The team will be evaluated on how the project is communicated to the school and the local community, considering web pages, social media, presentations, promotional material, media coverage, etc. The outreach effort should include, as much as practical, presentation of the design and development process.

## Scoring

The overall balance between the items to be evaluated is as follows:

| | |
|---|---|
| Technical achievement | 35% |
| Scientific value | 30% |
| Professional competencies | 25% |
| Educational Outreach | 10% |
| **TOTAL** | **100%** |

## Penalties

Teams' final scores will be penalised with 1% per day of late submission of the CanSat Pre-Launch Report. Similarly, 1% of the final score will be subtracted per $20 extra spent over the maximum CanSat budget of $800.

# Launch Campaign – Advanced Category

For the **Advanced** category, teams are required to attend the **Advanced Category Launch Campaign**, which will be held in **Alberta**, in early May, 2024 (TBC). The participating teams will be required to raise the necessary funding in order to travel there. The CSDCMS will provide return bus transportation between Calgary airport and the launch campaign sites.

## Launch Campaign Preliminary Schedule

The following is the preliminary schedule for the launch campaign (all times are given in Mountain Standard Time), for the likely starting dates of either Thursday May 2, or Thursday May 9:

| Day | Time | Event |
|---|---|---|
| Thursday<br>May 2 or May 9 | 14:00 | Meet at Calgary airport to board the bus. Arrival in Lethbridge or Drumheller at ~17:00. |
| | 19:00 | Opening Ceremony and welcome. |
| Friday | 09:00 | Team presentations. Each team is given a 20-minute time slot in which to present their CanSat and mission to the Jury. CanSats will be weighed and measured. |
| | 13:00 | Safety Drop Test. Each teams CanSat will be dropped from a height of 100m, and timed to ensure that its descent rate is within the required range. |
| | 19:00 | Possible evening activity. |
| Saturday | 08:00 | Teams board the bus to travel to the launch site. The teams will be on-site until approximately 17:00. CSDCMS will provide water, snacks, and lunches. There will be toilets on-site. |
| Sunday | 08:00? | Back-up day for launching.<br>Presentation of results by the teams.<br>Awards Ceremony. |
| Monday | 09:00 | Board the bus for travel back to Calgary airport. The bus is expected to arrive at the airport by 11:00. Please book return flights for no earlier than 14:00. |

**Preliminary Schedule for the 2023-24 Advanced Category Launch Campaign.**

## Technical & Safety Verification

To verify that the CanSats are suitable for launch, a technical inspection and a drop test will take place at the beginning of the Launch Campaign. The way the requirements are evaluated is as follows:

- Requirements 1, 2, 3, 7, 12 and 15 will be evaluated on site by the Jury. Teams that don't pass one or more of the tests on the first attempt will be permitted one second chance to amend the issues, to meet all the requirements. In case of failing at the second attempt, the team will be considered not to have achieved flight status and their CanSat may not be approved for launch.
- Requirements 10 and 13 refer to tests that should be carried out prior to the Launch Campaigns. The proof of the successful completion of these tests being should be stated in the Pre-Launch Report.
- A statement of confirmation that the each of the requirements has been met should be included in the Pre-Launch Report, paying special attention to requirement 14, which must be stated in the document.

## Launch Profile

The launch may be conducted by amateur high-power rockets, or the CanSats might be dropped from a helicopter or drone. Note that the physical conditions experienced by the CanSat will differ depending on the launch method:

- If a rocket launch is used, the CanSat will most likely be integrated into the rocket in a horizontal orientation, then brought to a vertical orientation at the launch pad. The launch will consist of a short duration of very high acceleration (up to 20g), followed by a coast phase of near free-fall conditions ("zero-gravity"), then the CanSat is ejected near apogee.
- If a helicopter or drone deployment is used, the CanSat will be carried aloft in either a horizontal or vertical orientation, and then dropped in a vertical orientation. It will not experience any high acceleration or free-fall conditions like a rocket launch would.

Note that the CanSat will need to be turned on before integration into the rocket, or before the helicopter/drone flight begins.