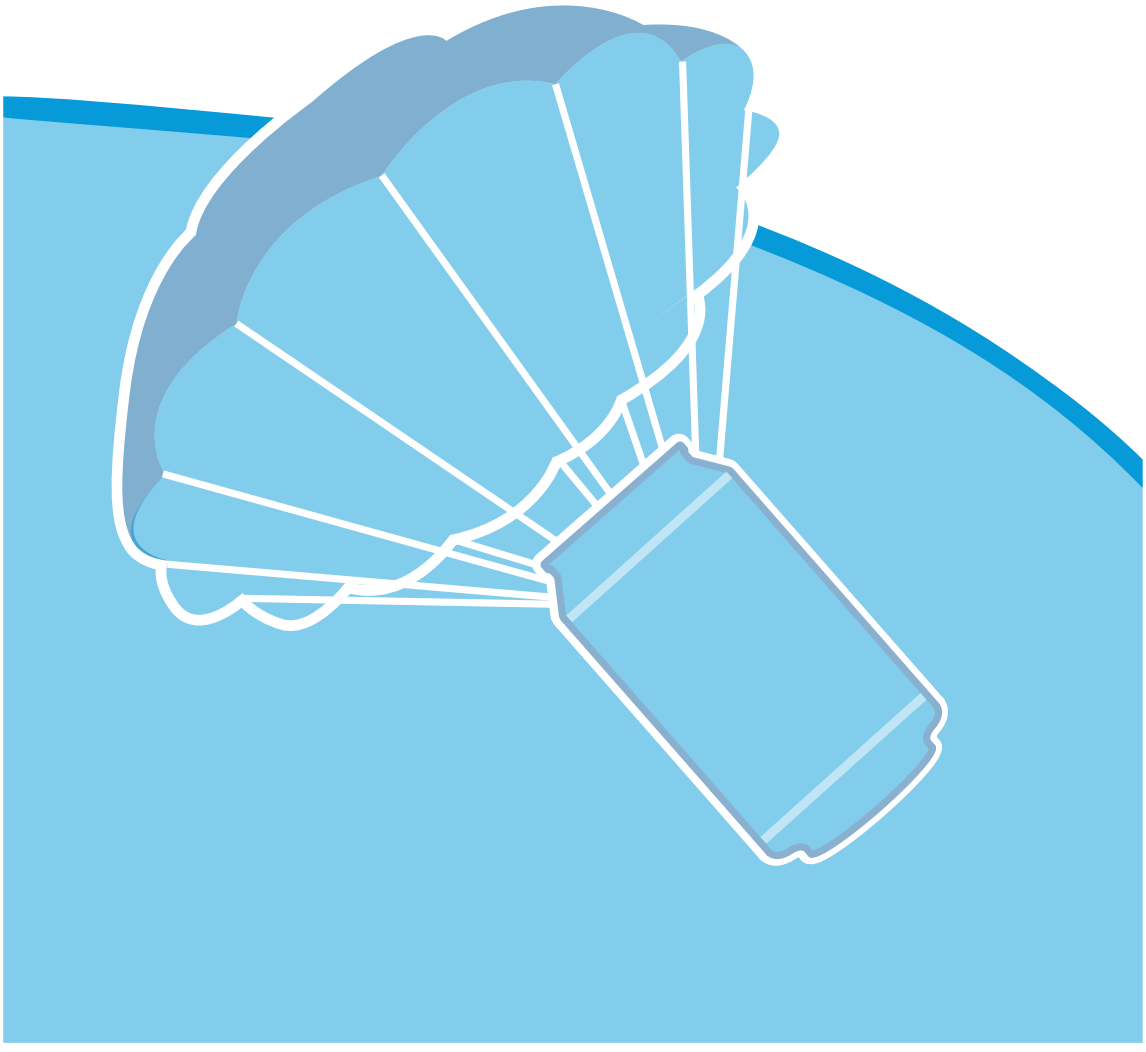
teach with space

→ GETTING STARTED WITH CANSAT

A guide to the Primary Mission



European Space Agency

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FAST FACTS

Age range: 14-19 years old

Supporting resources: Meet Arduino! Basics of satellites, Radio communications , Parachute design

Curriculum links: electronics, programming, mathematics

Complexity: Medium

Methodology: Project based learning

Outline

This module outlines the main features of the Primary Mission for CanSat. In the Primary Mission, teams must measure the temperature and pressure and send the information to their ground station. Students will learn about the differences between the sensors they can use and about the challenges associated with completing the Primary Mission. This module is designed in line with a range of resources to support the entire CanSat mission.

Students will learn

- The basic knowledge required in order to assemble and perform CanSat's Primary Mission
- How sensors work: thermistor & atmospheric pressure sensor
- Basic electronics: Ohm's law
- How to collect data from a resistance based sensor – using a voltage divider circuit
- Soldering

Activity 1: The basic components

This activity gives students an overview of the key components required for the CanSat Primary Mission. This can be used to allow students to appreciate the complexity of the CanSat mission, by considering the different options available for each component.

Exercise Answer

When a current flows through a resistor, heat is generated. This means that the temperature being measured will be higher than the ambient temperature of the surroundings, because of the self-heating of the resistor. This can be even more important if the temperature sensor is placed near other components, such as the CPU, as they generate heat too.

Activity 2: Basic electronics

Now that students are familiar with the key components of the CanSat Primary Mission they are now ready to learn about how these components work. This activity provides an introduction to Ohm's law as well as information on how to calculate the resistance of a resistor and set up a voltage divider circuit.

Exercise Answer

This is a 4-band resistor with colours: brown, green, red, yellow
Using the chart, this means the resistance is 15x100Ω or 1500Ω

Bonus Exercise

In this exercise students must make use of their mathematics skills to rearrange and combine the two equations given below to give an expression for $\mathbf{V_{out}}$.

$$V_{in} = I(R1+R2) \quad \text{and} \quad V_{out} = I(R2)$$

The first step is to make **I** the subject of both equations:

$$I = \frac{V_{in}}{(R1+R2)} \quad \text{and} \quad I = \frac{V_{out}}{R2}$$

Now, we can replace the I from one equation with the expression from another, like so:

$$\frac{V_{in}}{(R1+R2)} = \frac{V_{out}}{R2}$$

Finally, we can rearrange the equation about to make $\mathbf{V_{out}}$ the subject (by multiplying by **R2**).
This gives us:

$$V_{out} = \frac{V_{in} R2}{(R1+R2)}$$

This equation allows us to calculate the output voltage of a voltage divider circuit, provided we know the input voltage and the value of the two resistors. This is the basic principle that many sensors are based upon.

Activity 3: Communicating with your CanSat

This activity begins to bring together the previous work by looking at how we communicate with our CanSats. Students are given a brief overview of two different 'communication protocols' used in electronics. Whilst it isn't necessary to fully understand these protocols for the Primary Mission, an appreciation is helpful, as some components are only compatible with particular protocols. Students will also have an understanding of the main differences between several available transceivers.

Activity 4: Putting it all together

In activity 4, students learn how to fit the components of the CanSat Primary Mission together, using solder boards and soldering. An introduction to the soldering technique is given. Students are made aware of the safety precautions that should be followed when soldering. Information on powering the CanSat is also presented, and the important considerations when deciding how to power the CanSat are briefly discussed. .

Exercise Answer

Satellites remain in orbit for long periods of time and therefore require an indefinite power source. The Sun is a great source for this power. Powering your CanSat in this way is problematic. Firstly, there is the size and weight restriction, this makes building a large enough solar panel difficult. Secondly, much of the radiation from the Sun is absorbed by the atmosphere, solar panels on ground are therefore much less effective than those in orbit.

→ LINKS

Information on how a Thermistor works:
https://en.wikipedia.org/wiki/Thermistor

Information on the principles of a pressure sensor:
https://en.wikipedia.org/wiki/Pressure_sensor

Information on the Piezoresistive effect:
https://en.wikipedia.org/wiki/Piezoresistive_effect

An introduction to the theory of, and building of a voltage divider circuit:
https://learn.sparkfun.com/tutorials/voltage-dividers

Information on the digital pins found on an Arduino:
https://www.arduino.cc/en/Tutorial/DigitalPins

A guide to soldering:
https://learn.sparkfun.com/tutorials/how-to-solder-through-hole-soldering

Data-sheet for the MPX4115A pressure sensor:
http://www.farnell.com/datasheets/8723.pdf

Adafruit and Sparkfun are two websites that provide sensors and components suitable for the CanSat Primary Mission:

https://www.adafruit.com/categories

https://www.sparkfun.com/

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www.esa.int/education

The ESA Education Office welcomes feedback and comments
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