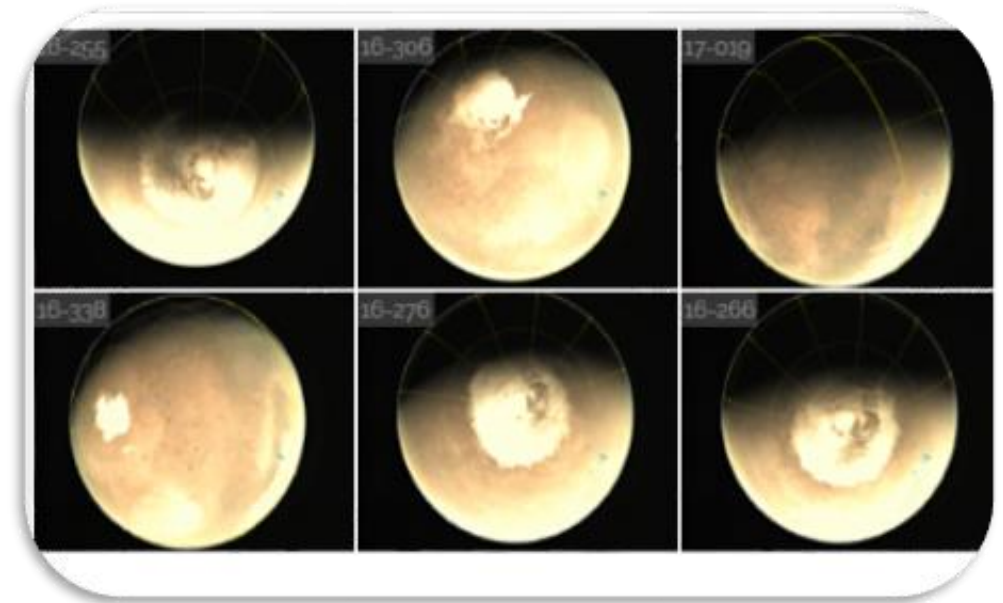


# Mars seasons

## CESAR Scientific Challenge

Exploring Mars with *Mars Express* and *ExoMars*



Beatriz González García on behalf of the CESAR Science Cases Team

The VMC camera, located on the scientific satellite of the European Space Agency (ESA), Mars Express, is sending us images of the surface of Mars.



ESA scientists and engineers want to program the Mars Express observations to obtain information needed for the preparation of the future ExoMars 2022 mission.



*Figure 1: Mars Express VMC camera images. (Credits: ESA)*

**Could we count on you to help our scientist?**

# ***Didactics***



Figure I: The considered top 10 skills in the 2020. (Credits: Rethinking).

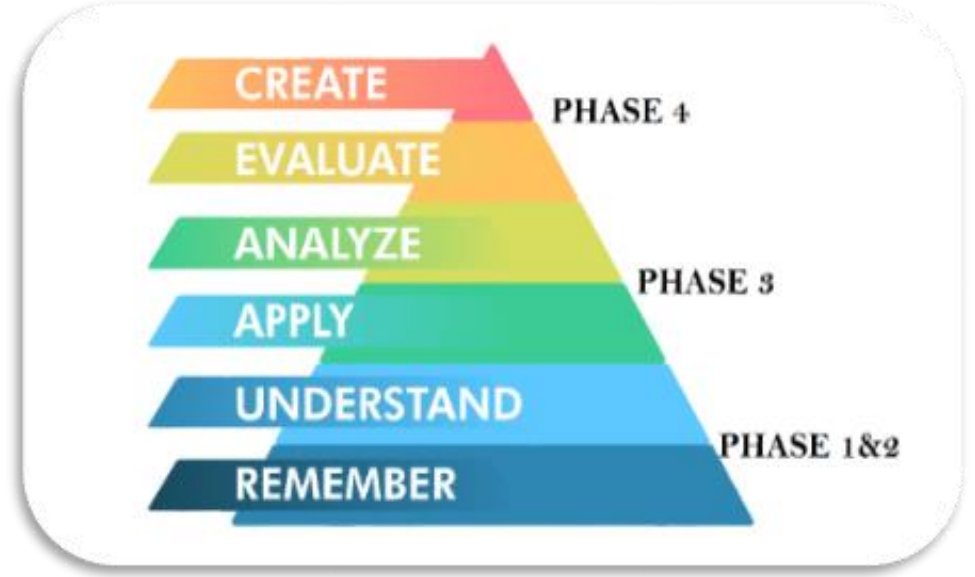


Figure II: Bloom's Taxonomy diagram. (Credits: <https://medium.com/@ryan.ubc.edtech/>)

Speaking: Rosa Doran (Cohost)  
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ΑΙΚΑΤΕΡΙΝΗΦΙΛΙΠΠΟΥ ΕΥΑΓΓΕΛΟΠΟΥΛΟΥ ΑΝΑ... ΚΡΟΜΠΑ ΒΕΝΕΤΙΑ ΦΙΛΙΠΠΟΥ ΑΙΚΑΤΕΡΙΝΗ

Viewing Rosa Doran's screen

# The Scientific Method

Curiosity / Question

Hypothesis

Plan and Run an Investigation

Gather and Analyse Data

Conclude and Check Hypothesis

Discuss and consider other solutions









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ESA GALILEO

A JOURNEY TO SPACE EXPLORATION MISSIONS GALILEO TEACHER TRAINING PROGRAM



Names				
Profession	Mathematician/ Software engineer	Astrophysics	Engineer	Biologist
Roles	She/he is in charge of leading the correct execution of calculations	She/he is in charge of planning the observations of the ESA/Mars space missions	She/he is in charge of finding the best strategy agreed between the members of the Team and its correct execution.	She/he is in charge of leading more detailed investigations on energy processes and composition of celestial objects
Reference	<u>Katherine Johnson</u>	<u>Vera Rubin</u>	<u>Samantha Cristoforetti</u>	<u>Marie Curie</u>
(female)				
(male)	<u>Steve Wozniak</u>	<u>Matt Taylor</u>	<u>Pedro Duque</u>	<u>Albert Einstein</u>
				

## ***Fast Facts***

**Age range:** 12-16

**Type:** Scientific challenge for students

**Complexity:** Medium

**Preparation time:** 1-4h

**Time required:** 3h - days

**Location:** Indoor

**Includes the use of:** Computers, internet

## ***Currículum relevance***

**General:** The method of science. The use of ICT

**Physics :** Rotation of the planets.

**Space/Astronomy:** Research and exploration of the Solar System. The seasons.

## ***The students should already know...***

- The basics of how the seasons work on Earth.
- How to identify features in images (e.g., polar ice caps)
- The connection between the size of the poles and the polar caps and the stations
- Mathematical elements.

### ***Students will learn ...***

- The basic properties of Mars compared to those of the Earth.
- How to handle astronomical images
- How the information, extracted from astronomical images, allows researchers to perform their scientific studies.
- The length of the Martian year.
- Process of a space mission

### ***Students will improve ...***

- Their understanding of critical thinking.
- The strategies of the scientific method.
- Their teamwork and communication.
- Self-evaluating skills.
- The application of theoretical knowledge to real situations.
- Their skills in ICT (Information and Communication Technology)..



# ***Let's get prepared for the Challenge***

# ***What do we already know?***

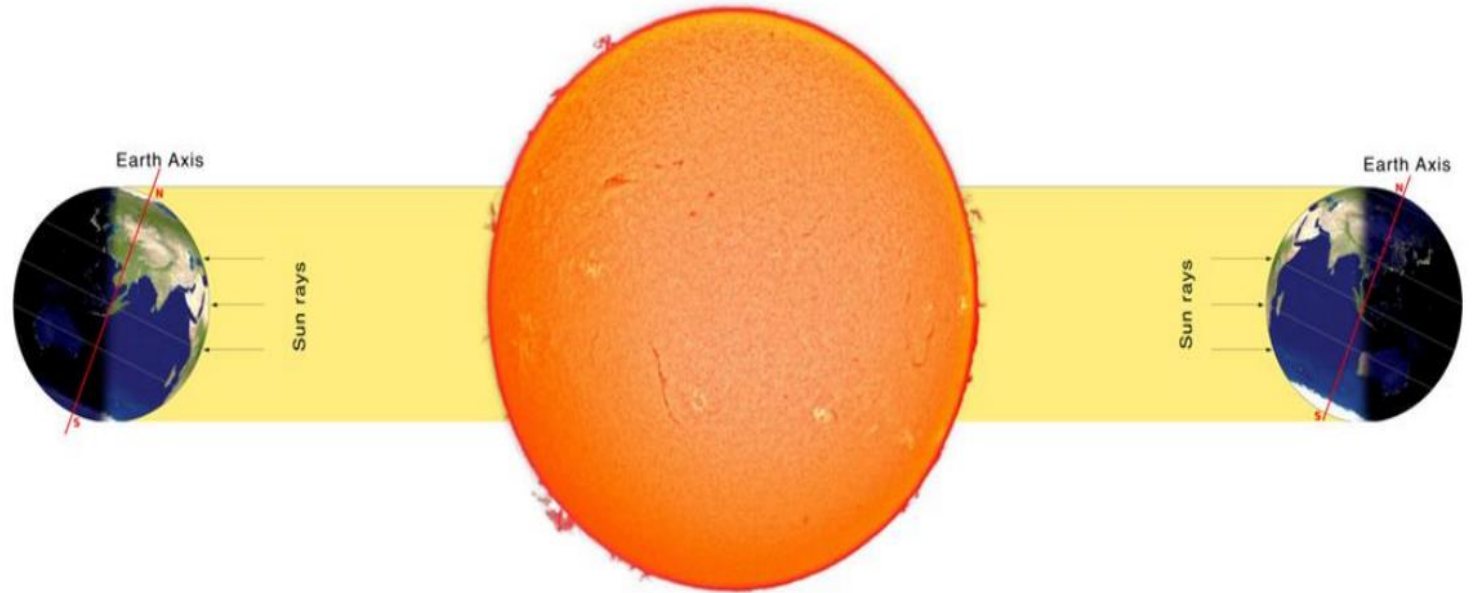
# <https://www.mentimeter.com/>

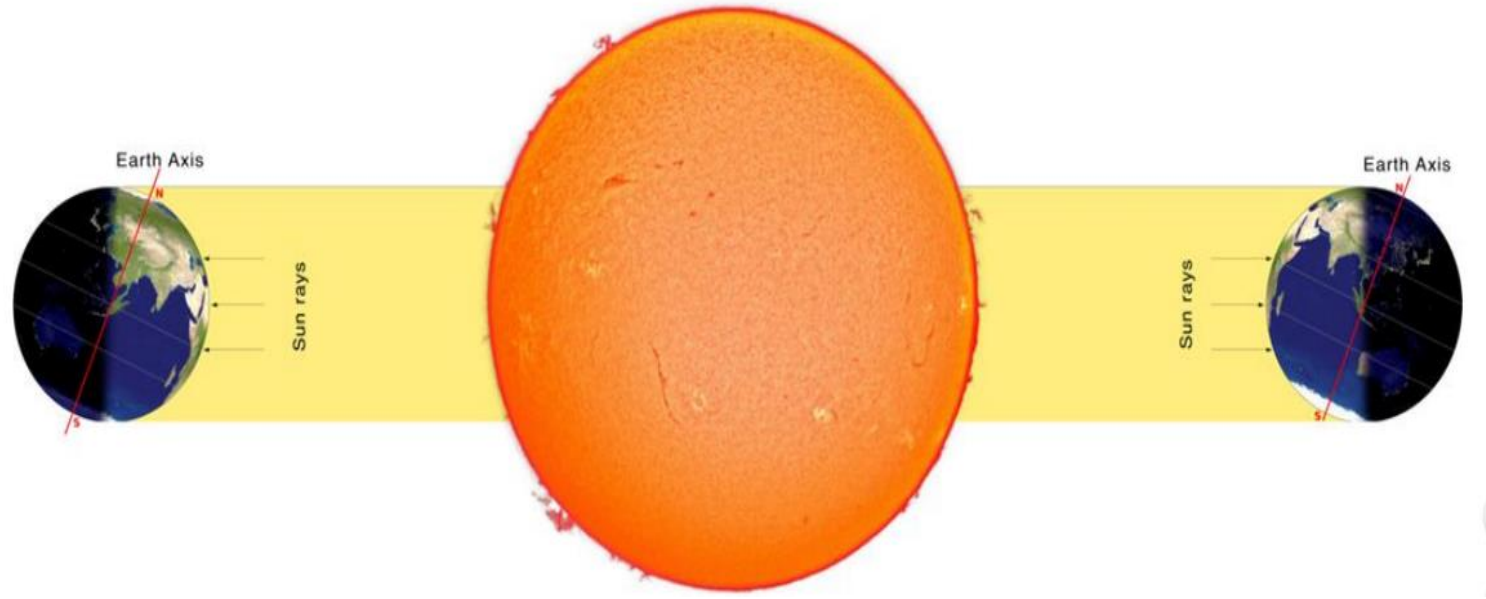
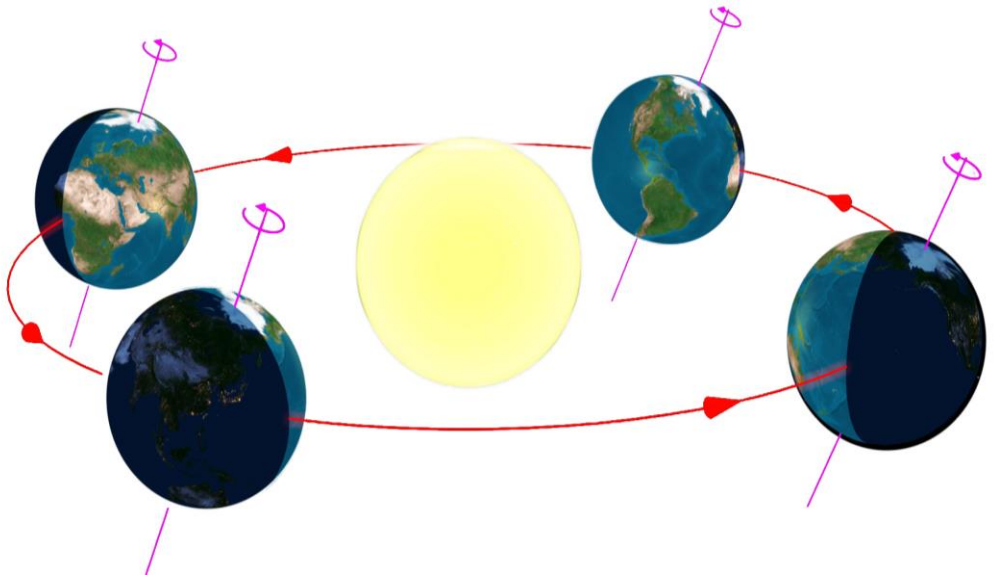
 

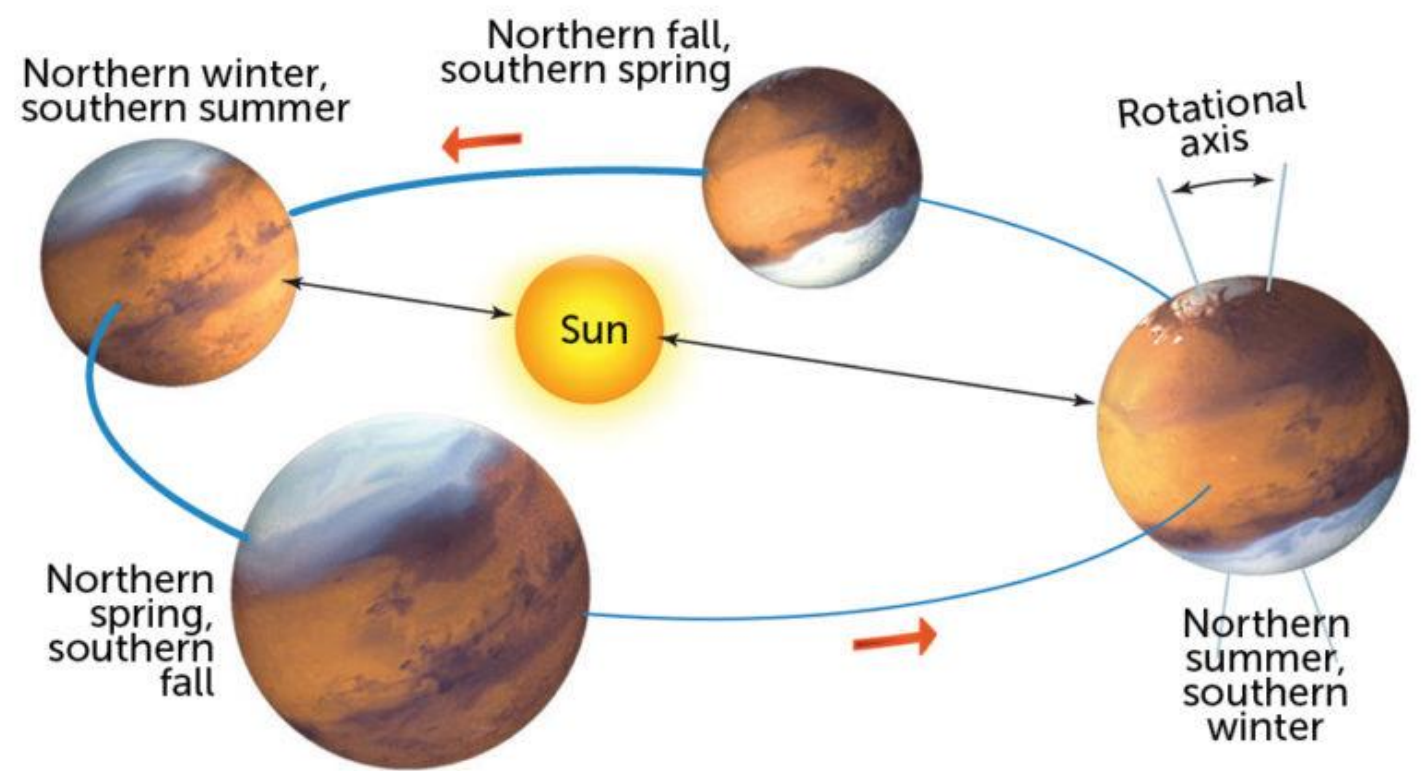
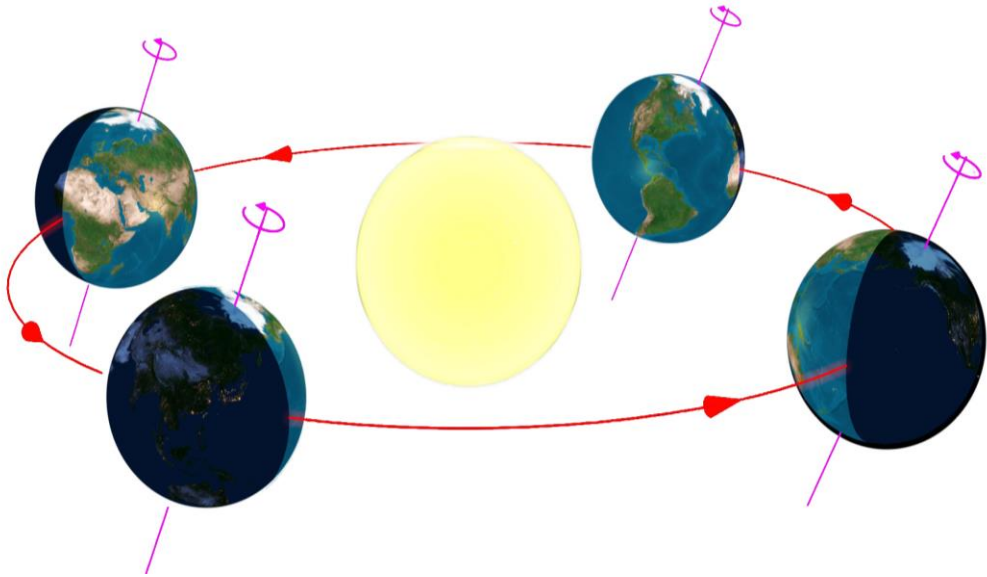
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**Code 71 49 90 1**







# ***Let's start the Challenge***

# ***Step 1***

Try to recognize Mars Seasons  
on ESA/Mars Express/VMC data



# CASE I. The seasons on Mars (Activity 9)

What information in scientific images of Mars could give you clues about the season? [Answer in the chat](#)

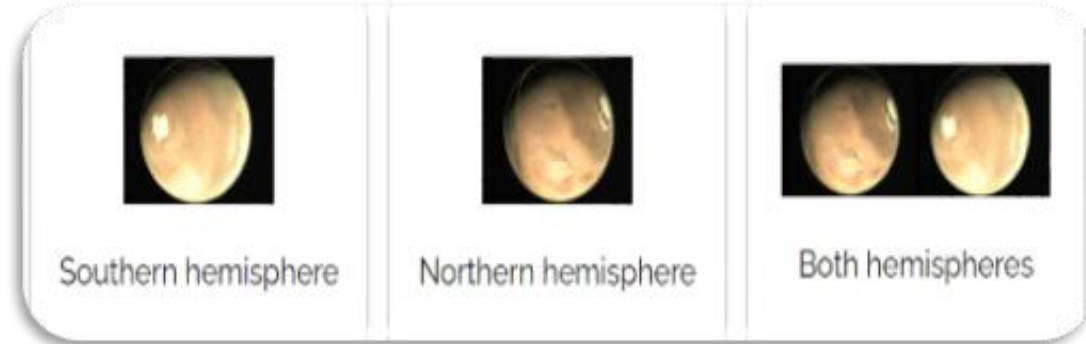
- The location of the polar caps, which are larger in winter than in summer.
- The appearance of dust storms that cover the surface of Mars, especially in summer.

1. Access images from the Mars Express VMC camera and identify Mars seasons by clicking on the web tool:

[http://cesar.esa.int/tools/18.martian\\_year/index.php?ChangeLang=en](http://cesar.esa.int/tools/18.martian_year/index.php?ChangeLang=en)

2. Execute the following steps:

- **Step 1/5:** Select from which hemisphere you will analyze the Mars images



- **Step 2/5:** Once you have chosen a hemisphere, identify which season each image corresponds to

Hint: the size of the polar cap will help you in this identification.



- **Check your results by clicking on the "Check" button!!**

# CASE II. How long does a year last on Mars? (Activity 10)

Now that you have learned to identify the seasons on Mars by looking at the evolution of the size of the polar caps, try to identify the length of a year on Mars .

- **Step 3/5:** Select a set of 6 images from the VMC camera that you consider to cover the same Martian year.

**Note 1:** All the images selected for the estimation of a Martian year must belong to the same hemisphere

**Note 2:** Each image is associated with an identifier. The numbering of the identifier **YY-XXX** corresponds to:

**YY:** earth year in which the image was taken.

For example, 16 refers to the year 2016.

**XXX:** or DOY , which ranges from 1 to 365. For example, DOY 32 corresponds to February 2.



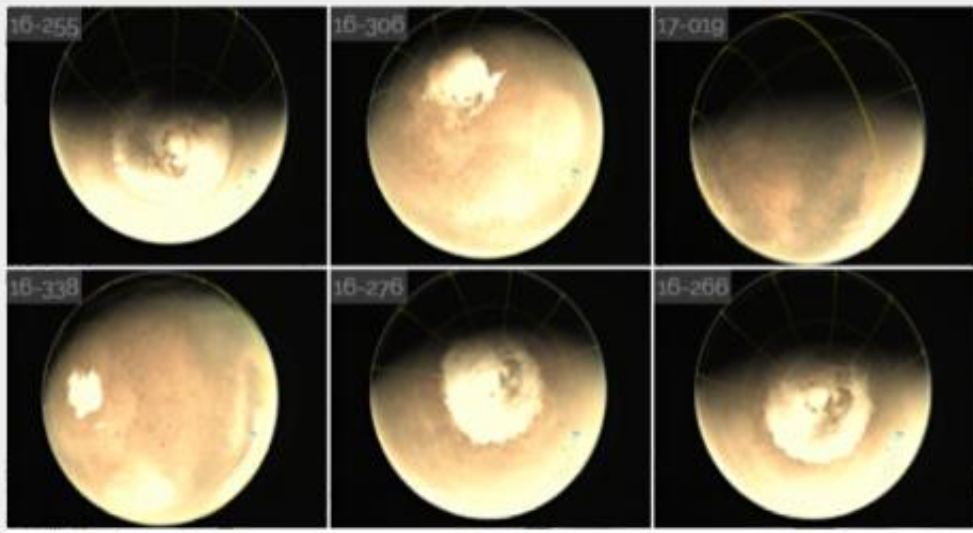
**Note 3:** Some images displayed in the tool appear almost dark. These correspond to the winter of Mars

**Step 4/5:** Enter the time between the first and last image chosen. This will be your estimate of the duration of a Martian year.

Tip: You need to do the calculation mentally or in a paper outside, the webtool will not make it from the selection of the images)

**Step 5/5: Check your results by clicking on the "Check" button!**

Step: 4/5  
Calculate the duration of a Mars year



**Task:**  
Insert the number of days for a Martian Year

**Tips:**

- Use the image identification (YY-XXX) to calculate the number of days between the images that are separated by the most amount of time in your selection.
- Each image has an identification number (YY-DOY) ⓘ

Now that you know how long a Martian year lasts,  
answer in the chat...

**How many Martian years would you have?**

- Look at this table with data on what you will find on your arrival on Mars, depending on the hemisphere in which you land on that date.
- Then fill in the Excel table with the results: <https://docs.google.com/spreadsheets/>

FACTORS	SUMMER @Northern Hemisphere	WINTER @Southern Hemisphere
The climate	Mild temperatures. Winds. Atmospheric pressure higher because of CO <sub>2</sub> in the atmosphere	Temperatures up to -130 ° C and carbon dioxide (CO <sub>2</sub> ) in the atmosphere is frozen, which reduces air pressure significantly
Dust storms	Dust storms	Less wind than in summer and therefore less dust storms.
Variations in polar caps	A reduced size of the polar cap made out of water ice, because the 1-m thin layer of dry ice (CO <sub>2</sub> ) was sublimated to the atmosphere.	The size of the polar caps increase considerably in size considerably (a permanent 8-m thick layer of dry ice).

