



BRITEC – Bringing Research Into the Classroom

Learning Scenario

1. Title

UV index – a closer look from Earth

Author(s)

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Area of research

Earth science

Subject(s)

Geography, Physics

Topic

Geographical factors affecting the UV Index

Age of students

15-19 years

2. Introduction

Contribution of the CS project to Science in general

The project introduces the concept of citizen science and basing on real scientific examples, shows how people can contribute to data collection. This case study focuses on the issues related to UV index as an element of solar energy reaching the Earth. Various geographical factors affecting the size of the index are presented. Students will also gain knowledge on how to protect themselves against the negative effects of UV radiation and will learn how to read the UV index and refer to their own needs.

The main goals of the project are:

making students aware of the possibility to take part in scientific projects without any



- professional scientific background;
- acquiring basic knowledge in the field of UV radiation;
- acquiring skills how to correctly collect data in the field of UV radiation.

Aim of the activities plan and learning objectives

The main goals of the activity plan are:

- Explain what UV radiation is and where it comes from.
- Presentation of main three types of UV radiation.
- Describe different geographical factors affect the UV radiation.
- Explain what UV index is and how it can be understood.
- Present a list of useful websites which can be used by a student.

The main learning objectives:

- Students can indicate the source of UV radiation.
- Students can list the types of UV radiation.
- Students can describe how different factors affect the UV radiation.
- Students understand UV index and how it relates to human health.

Skills acquire during activity:

- Critical thinking
- Communication and collaboration
- Information, Media and Technology Skills

Summary of activities

Number of activity	Name of activity
1.	From Sun to UV
2.	UVI factors over the world
3.	UV index and You



3. Detailed description of each activity (to be completed as many times as activities are implemented)

Activity 1: From Sun to UV

First Part: Aim of the activity

At the beginning of this activity, students become acquainted with the concept of civic learning. The Zooniverse.org website will be presented, where examples of such projects are shown.

Then the issue of UV radiation will be discussed, starting from the question of where solar energy comes from. Students will receive information on how the chemical reaction is responsible for producing solar energy, what the basic proportions of the solar system are, how powerful sun is, and finally the concept of UV will be presented. The division into three main types of UV radiation will be introduced, as well as the new UV index created in 2004. The last part of this activity is a quick brainstorming about the positive and negative effects of UV radiation.

Second Part: Suggested procedure

Preparation time	5'
Teaching time	15'
Online teaching material	Power Point or PDF reader application for Appendix_1_Presentation https://www.zooniverse.org/ Yt: Where Does the Sun's Energy Come From? https://www.youtube.com/watch?v=GAGFC8-wn1g
Offline teaching material	Equipment necessary for the presentation, i.e. a computer with internet access and a multimedia projector. Brainstorming can be carried out using a blackboard on which ideas will be written by the teacher, or by distributing markers and post-it notes to students to use them to write down their ideas.
Citizen science purpose of the activity (if any) *	A presentation of the basic concepts to better understand the collected data. The teacher's knowledge of the topic is necessary.
* Guidance for	If the topic is not well understood, then this part should be well



Third Part: Advice on methodology

For this activity you should have a room with the necessary computer equipment. In addition to the last part, it has the character of a lecture, during which it is suggested to ask questions stimulating students' curiosity. If you have time, you can also present the proposed YouTube video. The last part of this activity, which is brainstorming, can be carried out in two ways. The first way is less physically engaging and less time-consuming. Teacher writes down the students' ideas on the board. The second way is to give out sticky notes on which students will write their ideas. It is necessary to determine in advance where they will be placed by students in the room.

Fourth Part: Educational analysis

- Critical thinking and problem solving.
- Lifelong learning: learning does not stop after leaving school.
- Open source learning: teachers copy, share, adapt, and reuse free educational materials.
- Learning with the use of visual media: images and multimedia are more powerful than verbal stimuli.

Activity 2: UVI factors over the world

First Part: Aim of the activity

At the beginning of this activity, the most important factors affecting UV radiation reaching the Earth's surface will be presented. Then, in order to check how these individual factors change in different places on the globe, we suggest working in groups on the joint filling of previously prepared worksheet.

Each group selects the country and city (it does not have to be the capital), which they enter in the upper part of the survey. The pre-selected countries are presented for selection. Then, step by step, six issues are presented in which students, on their own, must obtain data from public sources and enter them in the appropriate place on the form.

The following six issues will be investigated: longitude and latitude, solar noon, sun's angle, altitude, amount of ozone, UV Index.



Second Part: Suggested procedure

Preparation time	5'
Teaching time	30'
Online teaching material	<p>PDF Reader Appendix_2_Worksheet</p> <p>https://www.google.com/maps/</p> <p>https://www.latlong.net/</p> <p>https://www.gps-coordinates.net/</p> <p>https://www.geoplaner.com/</p> <p>https://gps-coordinates.org/</p> <p>https://www.timeanddate.com</p> <p>https://www.suncalc.org</p> <p>https://astro.unl.edu/naap/motion1/motion1.html</p> <p>https://www.mapcoordinates.net/en</p> <p>https://www.freemaptools.com/elevation-finder.htm</p> <p>http://temis.nl/uvradiation/nrt/uvindex.php</p> <p>https://www.mapcoordinates.net/en</p> <p>http://www.weatherlink.com/user/igfpan/</p>
Offline teaching material	<p>Apps for phone: LunaSolCal Mobile, Sun Locator Lite, Google Earth, My elevation, GlobalUV</p> <p>Equipment necessary for the presentation, i.e. a computer with internet access and a multimedia projector. Paper to print worksheets, pens</p>
Citizen science purpose of the activity (if any) *	<p>The purpose of this activity is to gain experience in the understanding of acquiring sample data from publicly available sources on the Internet.</p>
* Guidance for teachers	<p>It is worth looking through the activities on each website presented in this part and practice obtaining this data yourself, based on different geographical coordinates.</p>

Third Part: Advice on methodology

To perform this activity, students must have access to either computers connected to the internet or be able to use their own cell phones with internet access. The maximum number of people in a group should not exceed 4. If there are more people in the class, increase the number of teams.



- Critical thinking and problem solving.
- Lifelong learning: learning does not stop after leaving school.
- Open source learning: teachers copy, share, adapt, and reuse free educational materials.
- STEM learning and getting familiar with STEM-related careers: increasing focus on Science, Technology, Engineering and Mathematics. Through this Learning Scenario students will be introduced to various STEM-related careers.
- Cloud Based Learning: data, tools and software are available online and can be reached and modified from different devices.
- Mobile learning and ICT literacy: we get access to knowledge through smartphones and tablets. It is learning anytime, anywhere.
- Learning with the use of visual media: images and multimedia are more powerful than verbal stimuli.
- BYOD (Bring your own device): students bring their own mobile devices to the classroom.

Activity 3: UV index and You

First Part: Aim of the activity

At the beginning of this activity, two factors are presented that should be taken into account when reading the UV indicator in the context of one's health, i.e. skin type and type of sunscreen and its sun protection factor.

Then, based on the indicated websites or applications, students are asked to check how much time they can spend in the sun without exposing themselves to sunburn. Awareness of the dangers arising from excessive exposure to the sun is to provide data on skin cancer incidence. Students have the opportunity to check which countries in the world have a particularly high number of cases of skin cancer.

The last element of this activity is evaluation. It can be done using an online quiz or more traditional forms, i.e. on paper.

Second Part: Suggested procedure

Preparation time	5'
Teaching time	15'
Online teaching material	PDF Reader Appendix_3_Quiz https://www.omnicalculator.com/other/sunscreen http://www.anycalculator.com/tanningcalculator.html https://canceratlas.cancer.org/risk-factors/ultraviolet-radiation



	<p>Apps for phone: UVlower, UVImate</p> <p>Yt clips:</p> <p>What does SPF mean and do UV filters damage coral reefs? https://www.youtube.com/watch?v=KPqocgl1-kc (remember about English subtitles)</p> <p>Sunburn and skin cancer, the burning issue https://www.youtube.com/watch?v=kmqhzG8QamU</p> <p>This tiny UV camera will show if you've missed any areas with sunscreen https://www.youtube.com/watch?v=-z4xQdQiZ18</p> <p>Quiz: https://quizizz.com/admin/quiz/5edb82b6c3676f001ba1e974</p>
Offline teaching material	<p>Equipment necessary for the presentation, i.e. a computer with internet access and a multimedia projector. Paper to print quiz if needed, pens.</p>
Citizen science purpose of the activity (if any) *	<p>The purpose of this activity is to show how participation in a civic project can broaden knowledge and skills useful in everyday life.</p>
* Guidance for teachers	<p>It is worth checking your skin type before the activity, as there are often problems distinguishing them.</p>

Third Part: Advice on methodology

This part has the character of a lecture interspersed with two activities actively involving students. As in the previous part, students must have access to either computers connected to the internet or be able to use their own cell phones with internet access. If the teacher has more time, then YouTube videos can be presented.

In this case, it is suggested that each student have their own access to such a device, so probably a cell phone will be more appropriate. If there is no time to complete the quiz, the page on which it was prepared gives the opportunity to do it later as homework. The quiz is available until the specific day and time.

The quiz can also be carried out in a traditional way using pre-printed questions on a piece of paper.

Fourth Part: Educational analysis

- Critical thinking and problem solving.
- Lifelong learning: learning does not stop after leaving school.
- Open source learning: teachers copy, share, adapt, and reuse free educational materials.



- STEM learning and familiarization with STEM-related careers: increased focus on Science, Technology, Engineering and Mathematics. Through this Learning Scenario students will be introduced to various STEM-related careers.
- Cloud Based Learning: data, tools and software are available online and can be reached and modified from different devices.
- Mobile learning and ICT literacy: we get access to knowledge through smartphones and tablets. It is learning anytime, anywhere.
- Learning with the use of visual media: images and multimedia are more powerful than verbal stimuli.
- BYOD (Bring your own device): students bring their own mobile devices to the classroom.

4. Assessment after implementation of the activities plan

Student's learning

Assessment method of the lesson can be a quiz. It can be conducted as a final part of a lesson or assigned as homework. Quiz is prepared in traditional way (Appendix 3&4) and also available on a Quizizz platform:

<https://quizizz.com/admin/quiz/5edb82b6c3676f001ba1e974>

Here are the questions with answers.

- **How does the sun create energy?**
- **By nuclear fusion**
- Bu nuclear decay
- from stars
- from void

- **Which type of UV radiation almost entirely reach the Earth's surface?**
- UVC
- UVB
- **UVA**



- **What is the name of time when sun peak in the sky?**
- sunrise
- sunset
- solar noon
- solar max

- **What is crucial for sun's angle on Earth?**
- latitude
- longitude
- altitude

- **How does altitude change UV radiation?**
- increase
- decrease

- **How do we call unit that measures ozone concentration?**
- uvi
- Dobson unit
- Pascal unit
- SPF

- **What is the safe range of UV index?**
- 1
- 1-2
- 1-3
- 1-4



- **How many types of skin were proposed by Thomas B. Fitzpatrick?**
 - 4
 - 5
 - **6**
 - 7

- **How many more minutes can you spend in sun with SPF 30 if your skin gets sunburn after 1 min without SPF?**
 - 5
 - 10
 - 15
 - **30**

- **Which of following countries has the highest rate of skin cancers cases per capita?**
 - Egypt
 - **New Zealand**
 - Japan
 - Kenya

Citizen Science experience

The main problem that students have is the correct reading of the individual indicators used in the lesson. Therefore, it is always recommended to provide an example of the form in which a given indicator should be written.

If students decide to read the data from applications installed on the phone, it is recommended to provide a list so that students before the lesson, so they can install the necessary apps on their phones.



5. Bibliography

<https://eris-project.eu/index.php/en/packages/>

<https://www.who.int/uv/publications/en/>

<https://www.epa.gov/sites/production/files/documents/uviguide.pdf>

https://ozonewatch.gsfc.nasa.gov/facts/dobson_SH.html

<https://www.sunsmart.org.nz/resources>

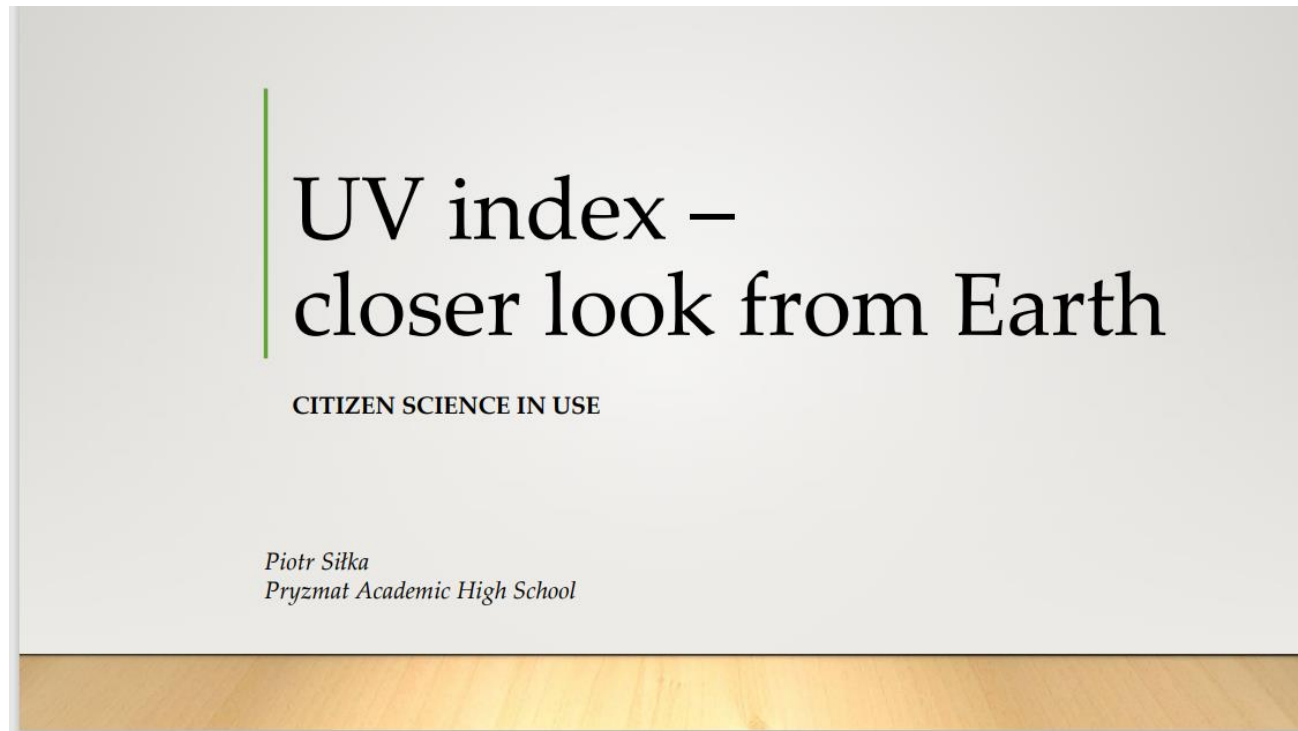
<https://canceratlas.cancer.org/risk-factors/ultraviolet-radiation>

<https://www.sciencelearn.org.nz/resources/1304-positive-and-negative-effects-of-uv>

<https://www.zooniverse.org/>

6. Annexes

Annex 1: Presentation



What is citizen science?

Citizen science is the practice of public participation and collaboration in **scientific** research to increase **scientific** knowledge. Through **citizen science**, people share and contribute to data monitoring and collection programs. Usually this participation is done as an unpaid volunteer.

What kind of topics???



<https://www.citizenscience.org/out-of-school/>

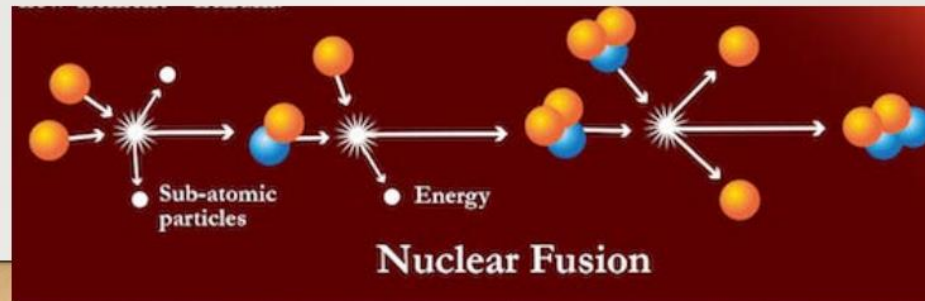
One of many examples...



<https://www.zooniverse.org/>

Sun energy

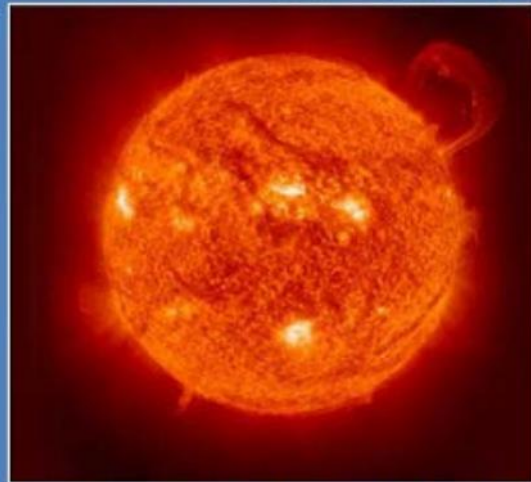
- Sun, like all stars, is able to create energy because it is essentially a massive fusion reaction.
- Thanks to the extreme pressure and temperature that exists within the core sun, energy is produced by hydrogen atoms (H) being converted into nuclei of helium (He).



<https://spaceplace.nasa.gov/sun-heat/en/>



SURFACE TEMPERATURE OF THE SUN & EARTH



6,000K (5,727°C or 10,340°F)

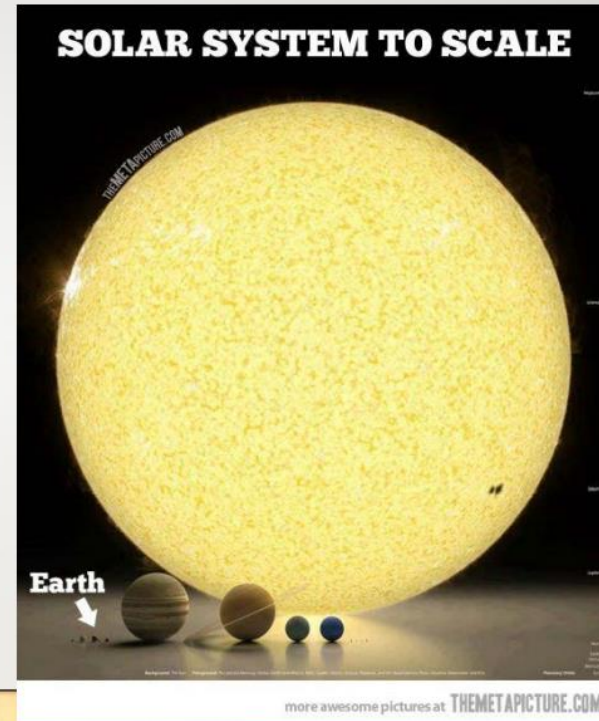


288K (15°C or 59°F)

<http://www.ces.fau.edu/nasa/module-2/correlation-between-temperature-and-radiation.php>

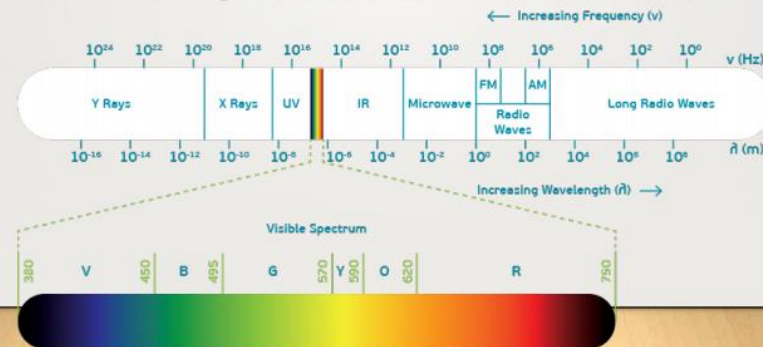
Distance is big, but sun is bigger

- Our solar system is so big it is almost impossible to imagine its size if you use ordinary units.
- The distance from Earth to the Sun is 149 million kilometers.
- 1.3 million Earths could fit inside the sun
- That is why each plastic model you can see in classroom is not true.



Solar radiation

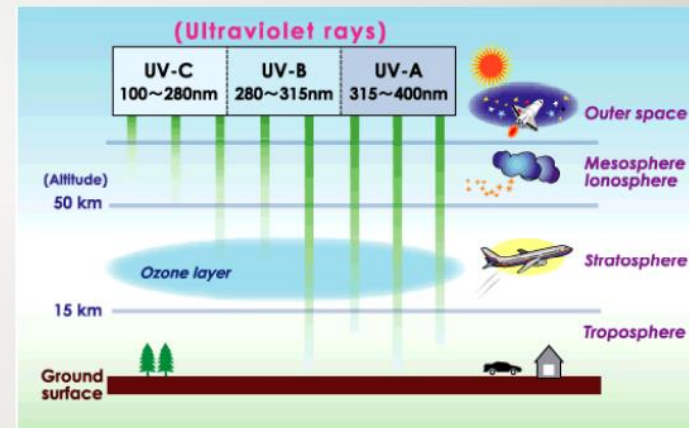
- All of the energy from the Sun that reaches the Earth arrives as solar radiation, part of a large collection of energy called the electromagnetic radiation spectrum.
- Solar radiation includes visible light, **ultraviolet**, infrared, radio waves, X-rays, and gamma rays.



<http://obeikanglass.sa/quality/solar-spectrum/>

UV radiation

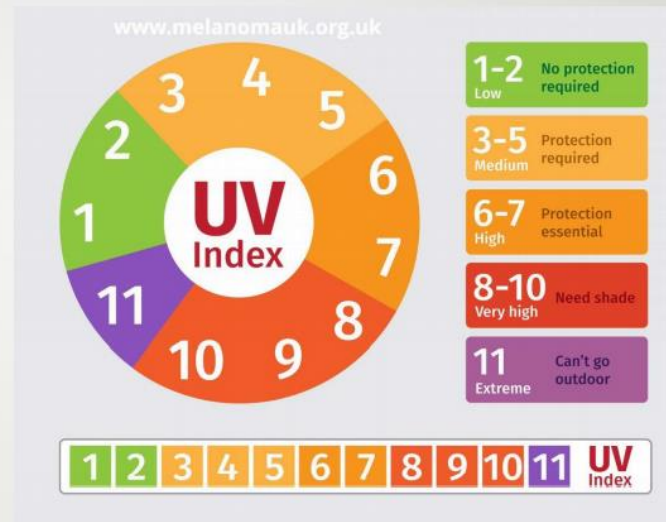
- UV radiation is classified into three types, according to the wavelength: UVA, UVB and UVC.
- UVC is completely absorbed by the atmospheric ozone, water vapour, and gases (O₂, CO₂).
- About 10% UVB and most UVA radiation reaches the Earth's surface.
- Both UVA and UVB are of major importance to human health.



<https://theozonhole.com/uvrays.htm>

UV Index

The Global Solar UV Index (UVI) described in this document is a simple measure of the UV radiation level at the Earth's surface and an indicator of the potential for skin damage.





Positive and negative effects of UV

What are the benefits and disadvantages of UV???



<https://www.everydayhealth.com/columns/therese-borchard-sanity-break/does-weather-affect-your-mood/>

Positive and negative effects of UV

	
<ul style="list-style-type: none">Triggers vitamin DHelps some skin conditionsHelps moodsHelps some animals' visionAids some insects' navigationUseful for disinfection and sterilisation	<ul style="list-style-type: none">Causes skin cancerCauses sunburnDamages immune systemDamages eyesAges skinWeakens plasticsFades colours

Factors affecting the UV radiation

Variations in the UV Index

The intensity of the sun's UV rays reaching the earth's surface, and the UV Index ratings, vary according to many factors. All influence the UV Index in locations across the U.S.

CLOUD COVER, if heavy, can block most UV radiation. Thin or broken clouds allow most UV rays through. Puffy, fair-weather clouds deflect rays and can increase UV radiation reaching the surface.

OZONE absorbs UV radiation. The higher the amount of ozone, the fewer rays reach the surface. Ozone levels vary from day to day and throughout the year.

ALTITUDE affects UV radiation; UV increases about 2% for every 1,000-foot increase in elevation due to thinner mountain air.

TIME OF DAY affects UV radiation, which peaks at midday (with the sun highest in the sky), and lessens in the early morning and late afternoon.

LAND COVER, such as structures and trees, significantly reduces exposure to UV radiation.

SEASONS affect UV radiation, which peaks in spring and summer (April to August), declines in fall, and is lowest in winter.

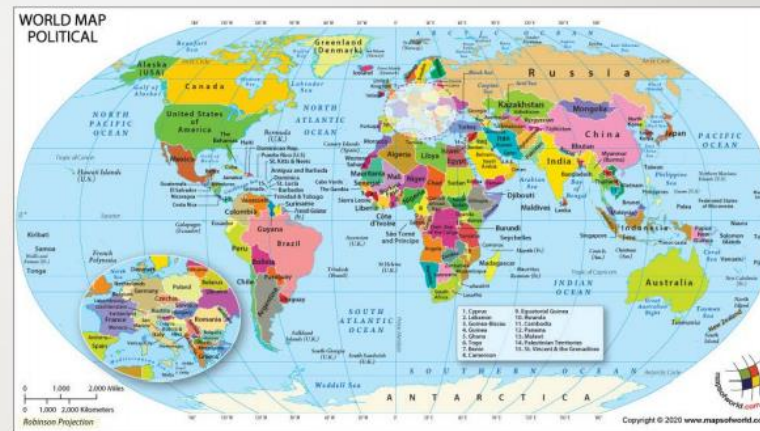
EARTH SURFACE CHARACTERISTICS can reflect or scatter UV radiation. Snow may reflect as much as 80% of UV, sand 15%, and water 10%.

LATITUDE affects UV radiation, which is strongest at the equator and declines toward the poles.

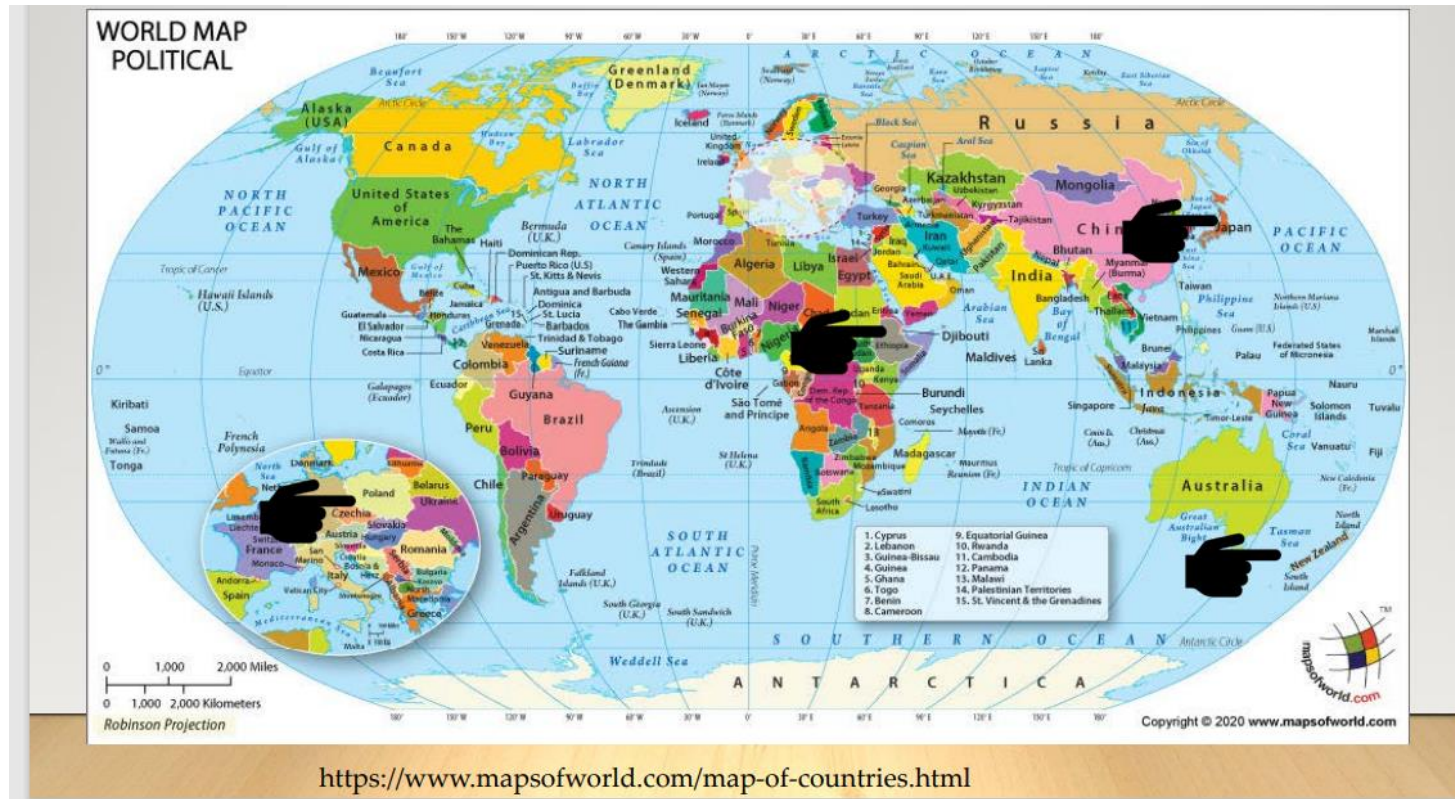
<https://www.epa.gov/sites/production/files/documents/uviguide.pdf>

UVI factors over to world

- Let's check how factors affecting the UV Index looks like in the different places in world.
- Please divide a class of students into 5 groups. Each group will investigate different country and city.
- You will find some examples on the next slide
- Each group will have a form to fill in (Annexes 2)



<https://www.mapsofworld.com/map-of-countries.html>

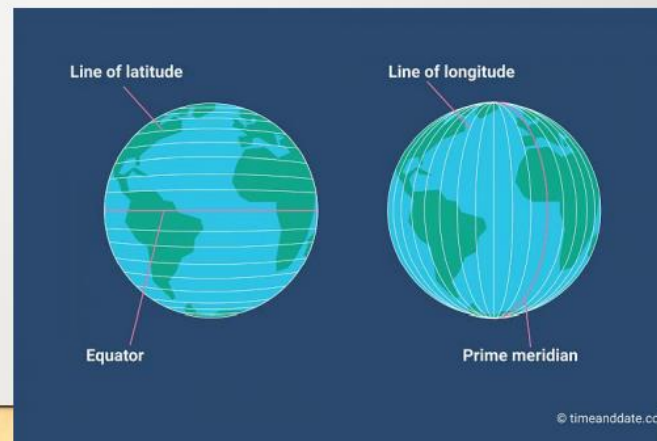


1. Longitude and Latitude

Write the geographical coordinates of your city.

You can use following sites:

- <https://www.google.com/maps/>
- <https://www.latlong.net/>
- <https://www.gps-coordinates.net/>
- <https://www.geoplaner.com/>
- <https://gps-coordinates.org/>



2. Time of the day

Write the time of solar noon in your city today.

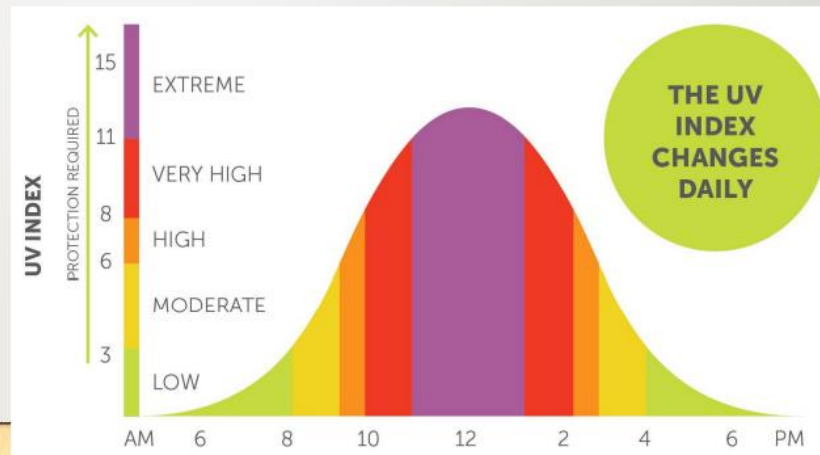
UV rays from the sun are strongest when the sun is at its peak in the sky, called **solar noon**, halfway between sunrise and sunset.

You can use following sites:

- <https://www.timeanddate.com>
- <https://www.suncalc.org>

Apps for phone:

- LunaSolCal Mobile
- Sun Locator Lite



<http://melanomawa.org.au/awareness/how-to-prevent-melanoma/>

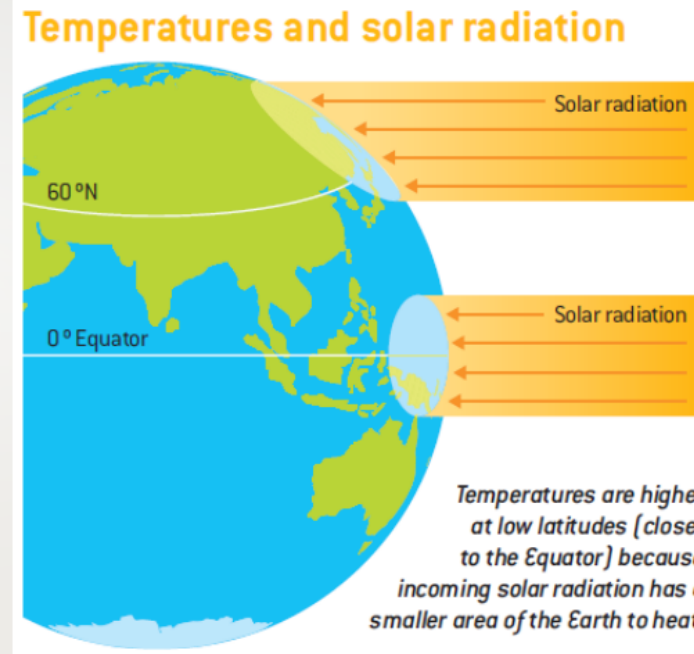
3. Latitude = sun's angle

Write the sun's angle during solar noon in your city today.

The most important determinant of the height of the sun and thus the amount of UV rays is latitude. The closer the equator, the higher the UV radiation levels. Of course, one should remember about the variability resulting from the time of day and season.

In addition to sites and apps mentioned before you can check also:

<https://astro.unl.edu/naap/motion1/motion1.html>



<https://sites.google.com/a/syd.catholic.edu.au/boudica/year-7-geography/4g1-investigating-the-world/global-pattern-of-climate>

4. Altitude

Write the altitude of your city.

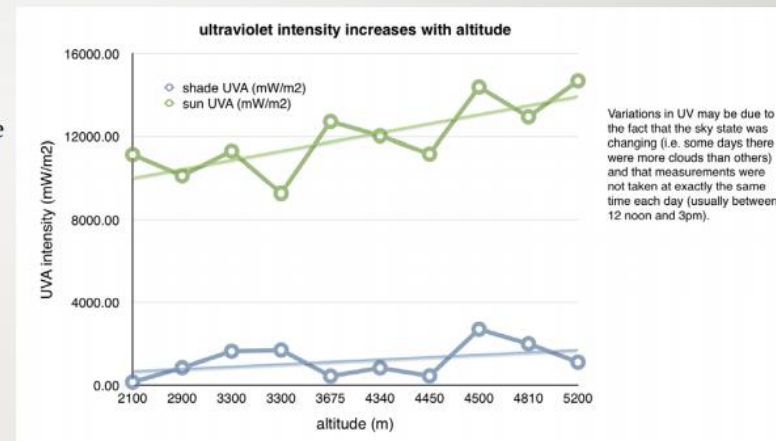
At higher altitudes, a thinner atmosphere filters less UV radiation. With every 1000 metres increase in altitude, UV levels increase by 10% to 12%

You can use following sites:

- <https://www.mapcoordinates.net/en>
- <https://www.freemaptools.com/elevation-finder.htm>

Apps for phone:

- Google Earth
- My elevation



<https://melaniewindridge.co.uk/mountain-science/mountain-science-preliminary-results-3.html>

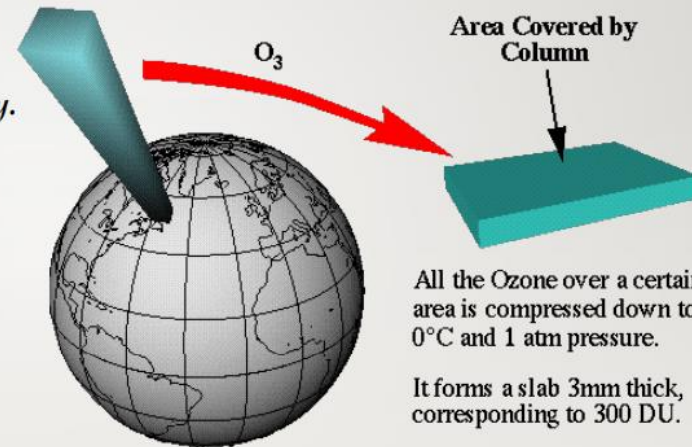
5. Ozone

Write the amount of ozone in you city for today.

Ozone absorbs some of the UV radiation that would otherwise reach the Earth's surface. Ozone levels vary over the year and even across the day. Dobson Unit (du) is the most common unit for measuring ozone concentration.

You can use following sites:

- <http://temis.nl/uvradiation/nrt/uvindex.php>



<https://theozonhole.com/dobsonunit.htm>

6. UV Index

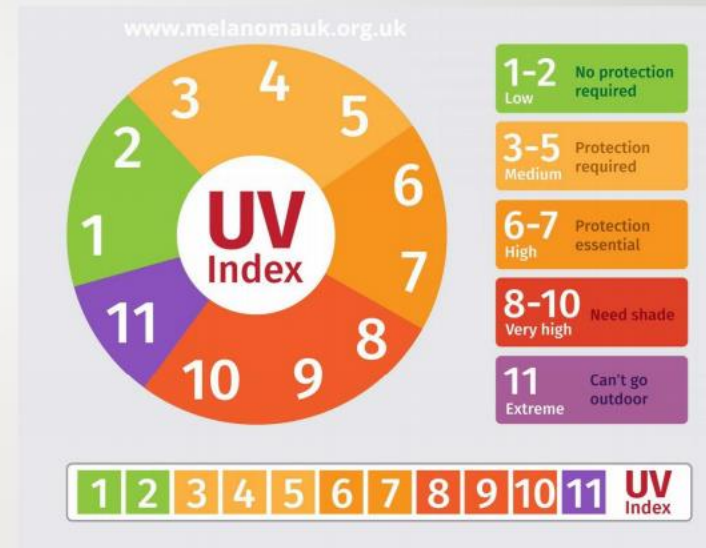
Write the highest UV index in your city for today.

You can use following sites:

- <https://www.mapcoordinates.net/en>
- <http://www.weatherlink.com/user/igfpan/>.

Apps for phone:

- GlobalUV



UV index and You

- Remember that the time you spend in the sun depends not only on UV index but also on your **skin type** and what kind of **sun protection** you use.
- Skin type - Thomas B. Fitzpatrick developed a way to classify the typical response of different types of skin to UV.
- Protection - sun protection factor (SPF) is a number, for example, SPF15. It indicates how much protection a product offers against UV light.

Skin Complexion	Sun's Effect on the Skin	Recommended SPF
Very Fair	Always burns easily; never tans	30-50+
Fair	Always burns easily; tans minimally	30-50+
Light	Burns moderately; tans eventually	15-30
Medium	Burns minimally; always tans well	6-15
Dark	Rarely burns; tans readily	2-10
Very Dark	Never burns; becomes deeply pigmented	2-10

http://www.hawaiiantropic.com/images/default-source/default-album/sunsafety_chart.gif?sfvrsn=2

UV index and You

Check how many minutes you can spend safely in sun today.

You can use following sites:

- <https://www.omnicalculator.com/other/sunscreen>
- <http://www.anycalculator.com/tanningcalculator.html>

Apps for phone:

- UVlower
- UVImate

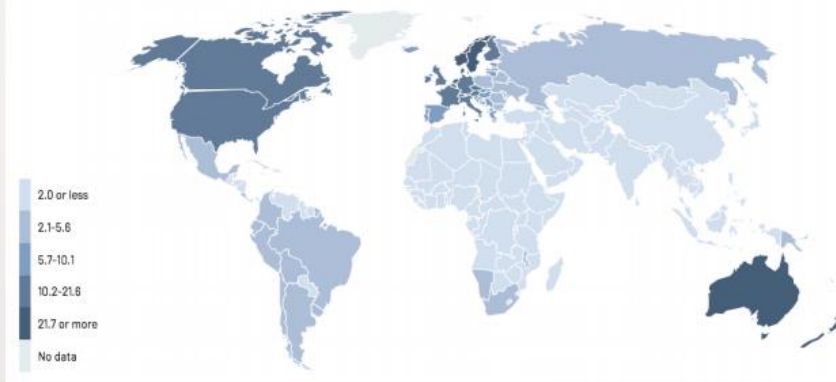
UV Index	Protection Steps	UV Strength
UV INDEX 1 2		LOW
UV INDEX 3 4 5	☑️ ☑️ ☑️ ☑️ ☑️	MEDIUM
UV INDEX 6 7	☑️ ☑️ ☑️ ☑️ ☑️	HIGH
UV INDEX 8 9 10	☑️ ☑️ ☑️ ☑️ ☑️ ☑️ ☑️	VERY HIGH
UV INDEX 11+	☑️ ☑️ ☑️ ☑️ ☑️ ☑️ ☑️ ☑️	EXTREME

Skin cancer

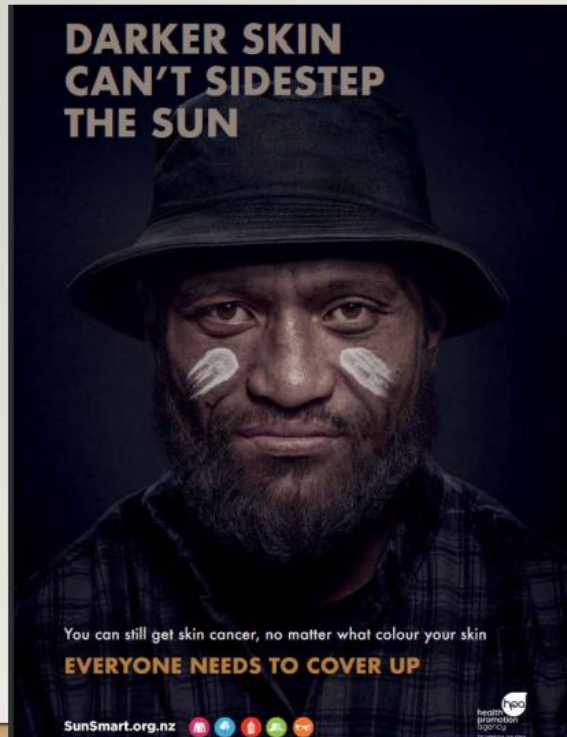
A majority of skin cancers are caused by ultraviolet (UV) radiation. Keratinocyte skin cancers (basal cell and cutaneous squamous cell carcinomas) are the most common human cancers with over 13 million cases estimated each year worldwide.

Melanoma skin cancer incidence

Age-standardized rate (world) per 100,000, both sexes, 2018



<https://canceratlas.cancer.org/risk-factors/ultraviolet-radiation>



Skin Cancer in New Zealand

New Zealand
currently has
the world's
highest rate
of skin
cancer,
including
melanoma.



<https://www.sunsmart.org.nz/resources>

CHECK YOUR KNOWLEDGE
BEFORE YOU GO

<https://quizizz.com/admin/quiz/5edb82b6c3676f001ba1e974>



Annex 2: Worksheet



UV in you country

Country: _____

City: _____

Date: _____

1. GEOGRAPHICAL COORDINATES
2. SOLAR NOON
3. SUN'S ANGLE DURING SOLAR NOON
4. ALTITUDE
5. AMOUNT OF OZONE
6. HIGHEST UV INDEX

Annex 3: Quiz

|| UV INDEX – CLOSER LOOK FROM EARTH

QUIZ

1. HOW DOES THE SUN CREATE ENERGY?

- by nuclear fusion
- by nuclear decay
- from stars
- from void

2. WHICH TYPE OF UV RADIATION ALMOST ENTIRELY REACHES THE EARTH'S SURFACE??

- UVC
- UVB
- UVA

3. WHAT IS THE NAME OF TIME WHEN SUN PEAK IN THE SKY?

- sunrise
- sunset
- solar noon
- solar max

4. WHAT IS CRUCIAL FOR SUN'S ANGLE ON EARTH?

- latitude
- longitude
- altitude

5. HOW DOES ALTITUDE CHANGE UV RADIATION?

- increase
- decrease

6. HOW DO WE CALL THE UNIT THAT MEASURES OZONE CONCENTRATION?

- uvi
- Dobson unit
- Pascal unit
- SPF

7. WHAT IS THE SAFE RANGE OF UV INDEX?

- 1
- 1-2
- 1-3
- 1-4

8. HOW MANY TYPES OF SKIN WERE PROPOSED BY THOMAS B. FITZPATRICK?

- 4
- 5
- 6
- 7

9. HOW MANY MORE MINUTES CAN YOU SPEND IN SUN WITH SPF 30 IF YOUR SKIN GETS SUNBURN AFTER 1 MIN WITHOUT SPF?

- 5

- 10
- 15
- 30

10. WHICH OF FOLLOWING COUNTRIES HAS THE HIGHEST RATE OF SKIN CANCERS CASES PER CAPITA?

- Egypt
- New Zealand
- Japan
- Kenya

Annex 3. Quiz with answers

|| UV INDEX – CLOSER LOOK FROM EARTH

QUIZ

1. HOW DOES THE SUN CREATE ENERGY?

- **By nuclear fusion**
- By nuclear decay
- from stars
- from void

2. WHICH TYPE OF UV RADIATION ALMOST ENTIRELY REACHES THE EARTH'S SURFACE??

- UVC
- UVB
- **UVA**

3. WHAT IS THE NAME OF TIME WHEN SUN PEAK IN THE SKY?

- sunrise
- sunset
- **solar noon**
- solar max

4. WHAT IS CRUCIAL FOR SUN'S ANGLE ON EARTH?

- **latitude**
- longitude
- altitude

5. HOW DOES ALTITUDE CHANGE UV RADIATION?

- **increase**
- decrease

6. HOW DO WE CALL UNIT THAT MEASURES OZONE CONCENTRATION?

- uvi
- **Dobson unit**
- Pascal unit
- SPF

7. WHAT IS THE SAFE RANGE OF UV?

- 1
- **1-2**
- 1-3
- 1-4

8. HOW MANY TYPES OF SKIN WERE PROPOSED BY THOMAS B. FITZPATRICK?

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- **6**
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About the BRITEC project

BRITEC – Bringing Research into the Classroom project (<https://britec.igf.edu.pl/>) aims to introduce the Citizen Science (CS) approach in schools as a way of engaging pupils in research practices. This project has been funded with support from the European Commission within ERASMUS+ Programme and is coordinated by the Institute of Geophysics, Polish Academy of Sciences.