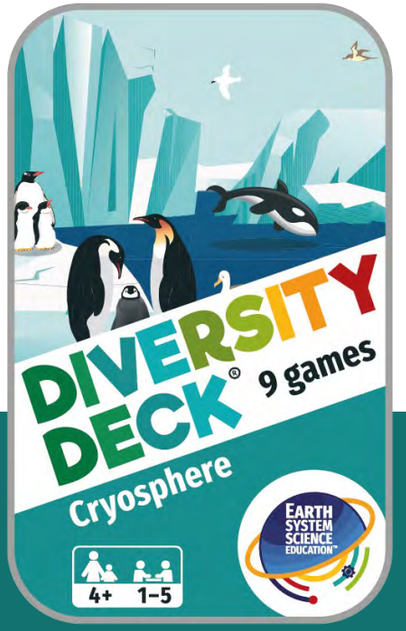
DIVERSITY DECK® Funbook



The Cryosphere matters!

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Junior JUNCTION

PLAY ● LEARN ● CHANGE THE WORLD

Earth System Science Education™

To understand how our planet works and our impact on it, we teach Earth System Science.

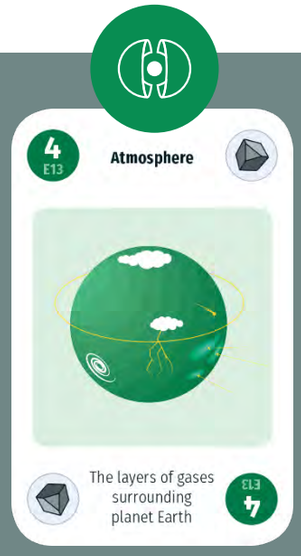
We divide the Earth into 7 different components called spheres.

Today, we will tell you the story of the Cryosphere.

E11

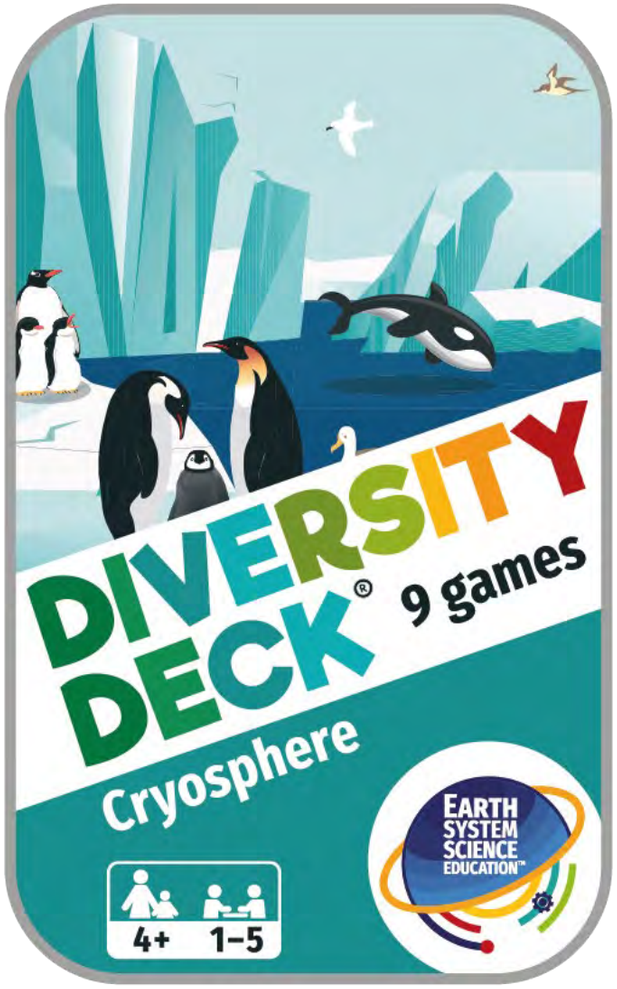
This symbol means there is further information available on our Educational Hub MAINTENANT.org.uk

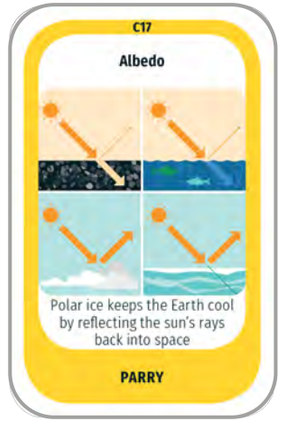
You can click on the weblink or type the reference, e.g. E11, into the search box.

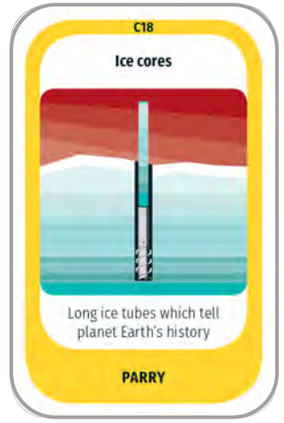


PLAY ● LEARN ● CHANGE THE WORLD

Use code **MSNOFF20** for 20% off DIVERSITY DECK® card games







DIVERSITY DECK® Funbook

PLAY ● LEARN ● CHANGE THE WORLD

Dear teachers, parent, carers or any curious mind,

Thank you so much for downloading our Cryosphere Funbook. Our hope is that you will use this to take your children on a fascinating jouney through the beautiful icey places on our planet and inspire children to protect it and want to study it whilst teaching them core values of sustainability such as environmental stewardship, global peace and inclusivity. We also promote the UN Sustainable Development Goals throughout the book and highlight when particular ones are relevant.

We have made this resource to either shape a scheme of work or be used as stand-alone activities within a scheme of work you already have in place, so it is very flexible and adaptable to your individual pedagogy.

The illustrations and content are designed to be simple and meaningful to focus attention on the information that matters and helps children to understand our planet. There are many cross-curricular elements which make for a well-rounded scheme of work and the contents page is laid out so that you can easily identify these.

We use Earth System Science to present and explain how the world works. This is reflected by using the 7 spheres (page 2) and when we talk about how the cryosphere interacts with other spheres, we don't have separate activities for those pages as the topics have their own Funbooks for you to refer to. Our educational hub is a wealth of resources to help you as a teacher understand the background to what you are teaching better and has links to outside webpages and other material which you may find interesting. You will find links on the top right-hand corner of each page.

Please get in touch if you would like any clarification or support at contact@maintenant.org.uk or indeed have any ideas or suggestions of your own. We are always looking to add to and improve our material. CPD sessions on teaching sustainable development are also available by request.

Kind regards,

The MAINTENANT Education Team

MAINTENANT Sustaining Now
maintenant.org.uk

DIVERSITY DECK® Funbook

Cryosphere

Sponsored by Junior JUNCTION

MAINTENANT are happy to announce that we have teamed up with Business Junction and their associate Junior Junction, as the official sponsors of the DIVERSITY DECK® Cryosphere Funbook!

- Business Junction, London's leading independent business network, is widely known for connecting thousands of companies since 2001. They are firm believers that every company has a responsibility to the environment and the planet, and to their employees and communities, to create a new way of working together for a better society.
- In 2019 Business Junction launched Junior Junction for the next generation. Informal, fun and informative events see children and young people coming together at exciting venues such as the London Transport Museum.
- Junior Junctioneers get to experience the valuable and diverse outcomes of meeting and connecting with children they have not meet before, and building new friendships. Through these experiences, children start to understand the value of becoming more informed, creating and identifying new opportunities, and recognising the importance of a more inclusive society.

Junior Junction gives you the opportunity to attend one of their events free of charge.

All you have to do is send an email to:

clare@businessjunction.co.uk

with the code: **BJJJMN1**

and you will be registered for our next event.

CONTENTS

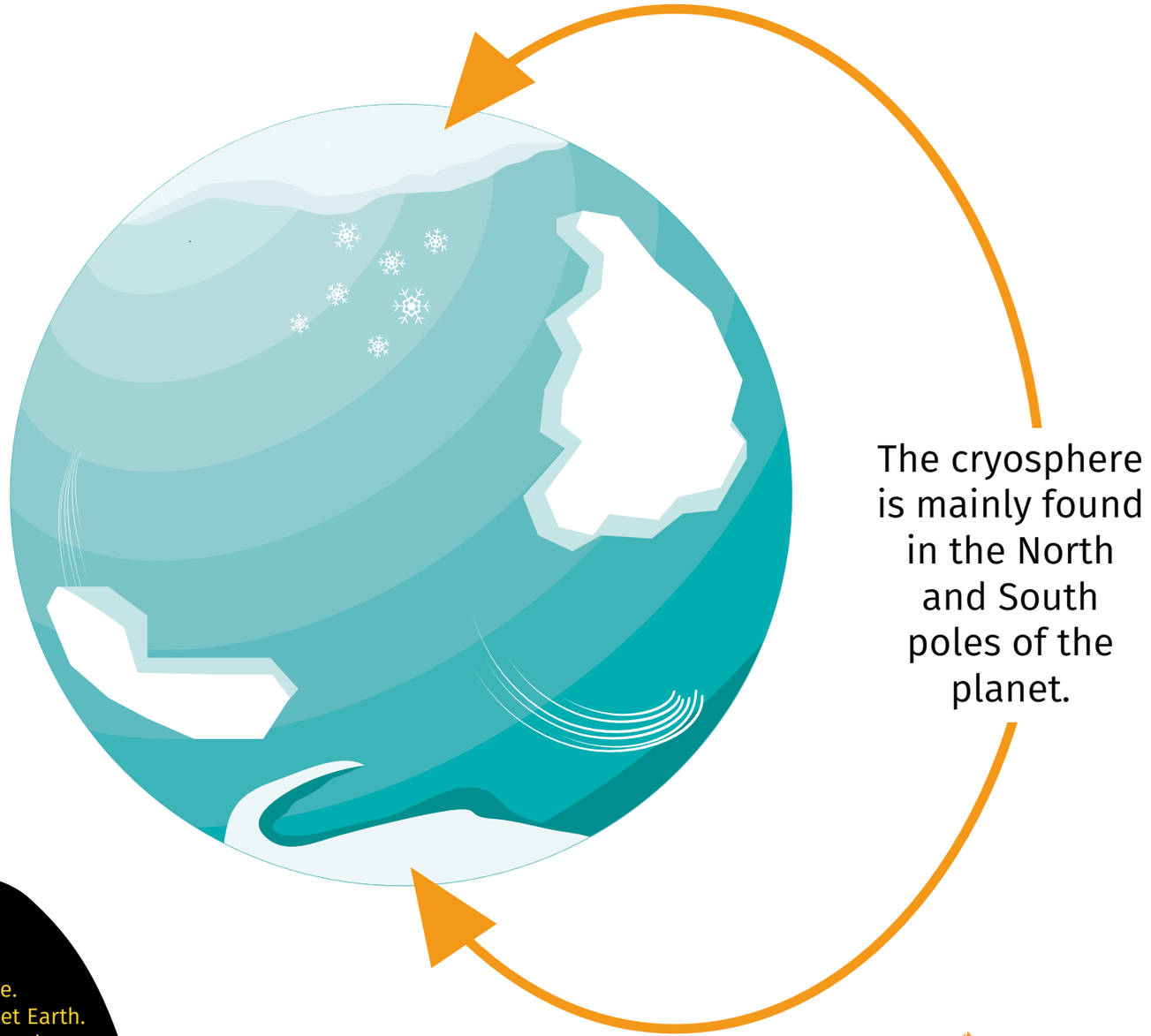
▲ Reading ■ Activity ● Experiment

PLAY ● LEARN ● CHANGE THE WORLD

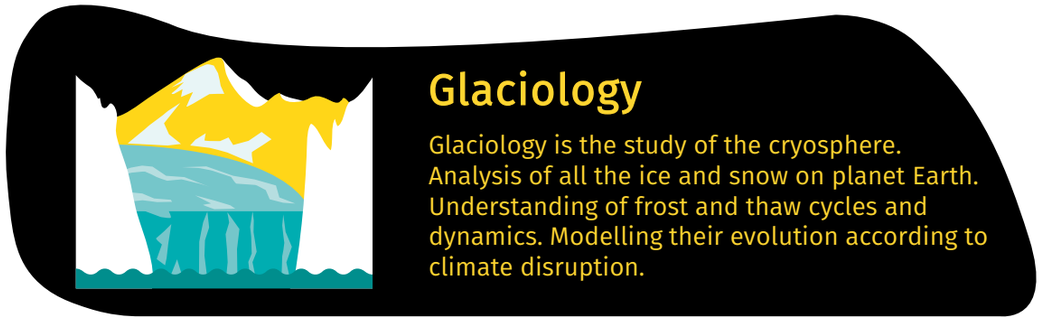
What is the cryosphere?

- It is all the frozen water on the planet and includes all the snow, glaciers, ice sheets, ice caps, ice floes and icebergs. These are mainly found in the polar regions.

- Glaciers and frozen mountain peaks are found in many high mountain ranges around the world such as the Himalayas and the Andes.



The cryosphere is mainly found in the North and South poles of the planet.



Glaciology

Glaciology is the study of the cryosphere. Analysis of all the ice and snow on planet Earth. Understanding of frost and thaw cycles and dynamics. Modelling their evolution according to climate disruption.

Cryosphere word search

- Complete this wordsearch to familiarise yourself with some words about the cryosphere. There is a glossary at the end of this book for you to use if you are not sure of their meaning. Some words are also linked to pages on our Educational Hub.

E	M	I	C	E	S	H	E	E	T	S	R	V	A	J
R	I	C	E	B	E	R	G	S	U	E	P	S	Z	X
E	G	S	D	K	J	A	L	B	E	D	O	Q	U	A
H	W	A	R	C	Y	N	I	E	R	O	C	E	C	I
P	U	R	S	A	H	T	G	P	O	L	A	R	S	R
S	N	O	W	F	L	A	K	E	F	O	I	T	E	G
O	B	R	F	R	I	R	Y	N	A	R	W	H	A	L
Y	T	U	O	O	S	C	A	G	T	C	H	U	L	A
R	L	A	K	Z	O	T	P	U	I	A	D	S	Z	C
C	A	W	H	E	R	I	C	I	G	T	X	K	O	I
E	F	I	J	N	H	C	U	N	L	N	R	Y	O	E
U	Q	P	E	R	M	A	F	R	O	S	T	E	L	R
G	R	E	E	N	L	A	N	D	O	P	M	C	A	S

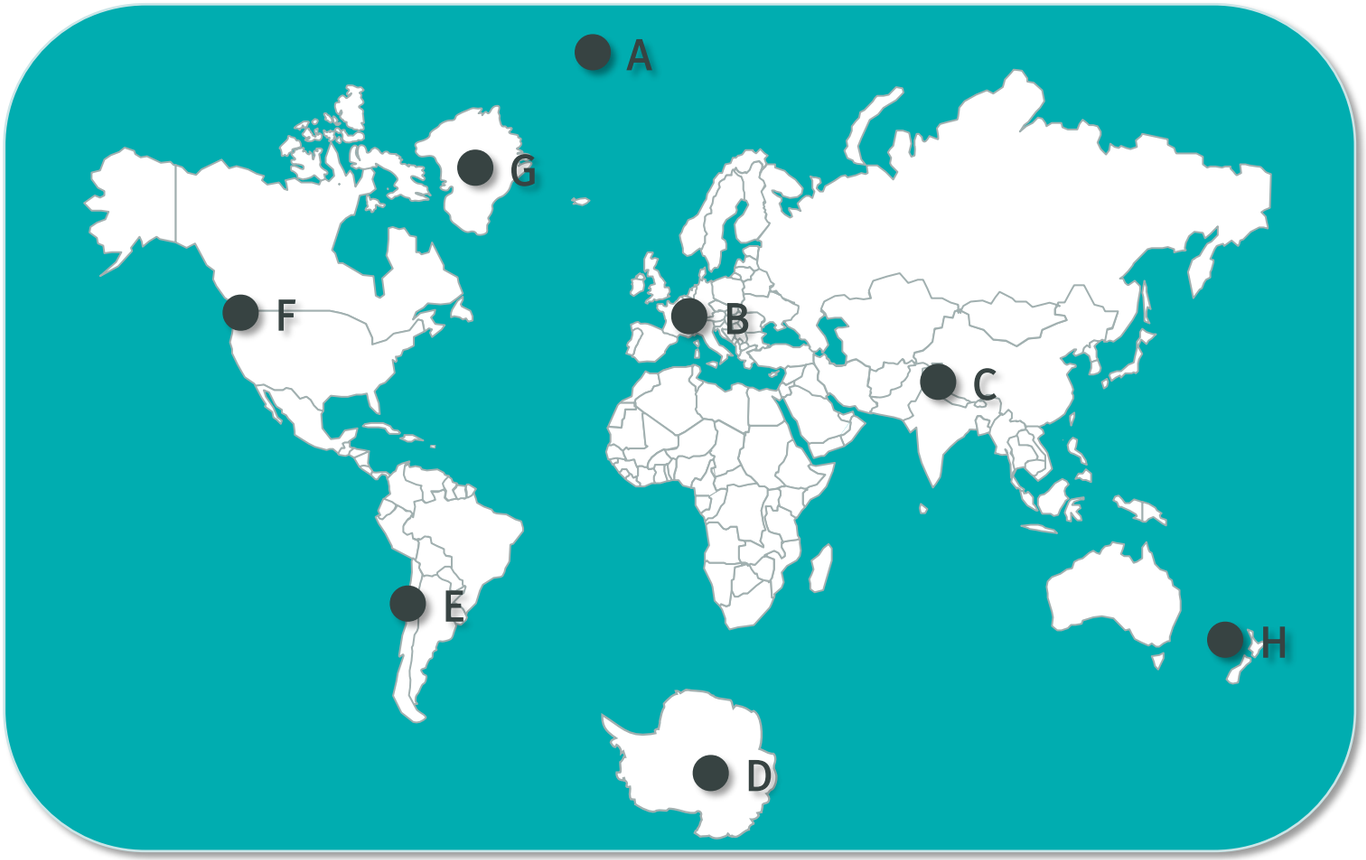
For the experts

- Where is the largest ice-sheet in the Arctic Circle?
- The answer is an extra word in the wordsearch

- [ ] Albedo
- [ ] Antarctica
- [ ] Auroras
- [ ] Cryosphere
- [ ] Frozen
- [ ] Glaciers
- [ ] Husky
- [ ] Icebergs
- [ ] Ice-core
- [ ] Ice-sheets
- [ ] Igloo
- [ ] Narwhal
- [ ] Orca
- [ ] Penguin
- [ ] Permafrost
- [ ] Polar
- [ ] Seal
- [ ] Snowflake

Where in the world is the cryosphere?

- The cryosphere is mainly found in the polar regions, but glaciers and ice-capped mountains can be found in most mountain ranges across the world.
- Can you label the map where the main areas of the cryosphere are found?



..... Antarctica

..... Arctic

..... Greenland

..... New Zealand Southern Alps

..... The Alps

..... The Himalayas

..... The Rocky Mountains

..... The Andes Mountains

Lands of extreme temperatures on either side of the globe

- The two poles are different to the rest of the planet.
- They have only two seasons with long summers and long winters because of the way the Earth tilts as it makes its way around the Sun.
  - In the summer, the Sun never sets
  - and in the winter, the Sun never rises.
- Even in the summer, the Sun is low on the horizon and very little of the Sun's energy reaches the poles, which means that they are the coldest places on the planet.
- Energy from the Sun strikes earth almost directly near the equator. Therefore, most countries near the equator have constant exposure to sunlight and experience much warmer temperatures all year-round than the rest of the world. Countries on the equator include almost half of the world's rainforests because plants grow better and larger with more of the Sun's energy.

TRY IT OUT

To visualize this phenomenon:
Shine a torch straight on at a wall (equator).
Shine the torch again but at an angle (poles). What did you notice?

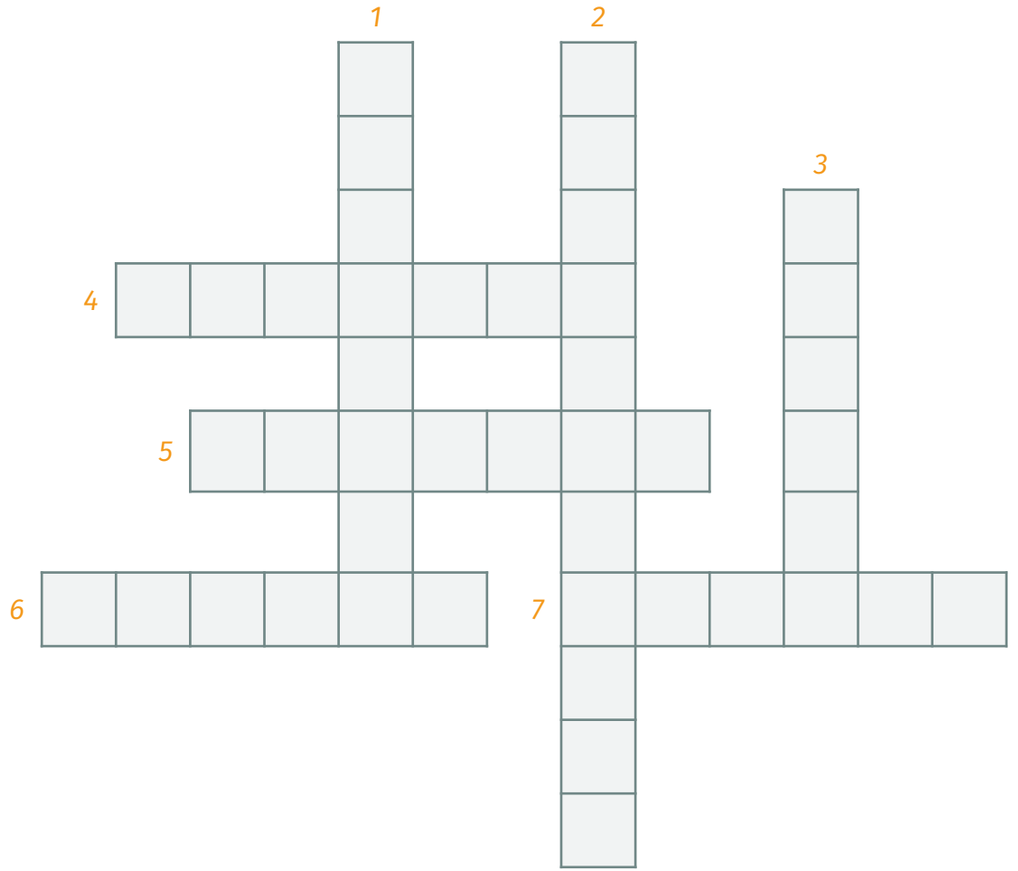
Class

Name

Surname

Date

Sun’s energy crossword



- Down
  1. The name given to the imaginary lines around the Earth which describe how far north or south you are.
  2. Levels of sunlight and rain near the equator are so great that it provides the perfect conditions for _ _ _ _ _ _ _ _ _ _ _ to grow.
  3. Near the Poles, the sun's energy is spread out making temperatures _ _ _ _ _ _.

- Across
  4. In the poles, the sun is always low on the _ _ _ _ _ _ _.
  5. Energy from the sun strikes the Earth almost directly at the _ _ _ _ _ _ _ .
  6. The season where the sun disappears for months on end in the poles.
  7. Different parts of the Earth receive different amounts of the Sun’s _ _ _ _ _ _ .

Arctic Ocean - Ice on water

- The Arctic Ocean is covered by sea ice.
- Every year, some of this ice melts in the summer and refreezes in the winter.
- The land surrounding it, in the Arctic Circle, is covered in ice and permafrost.
- No one country owns the Arctic Ocean, but every country surrounding it claims some of its waters.

The Arctic (North Pole)

FROSTY FACT

The Arctic Ocean is the smallest ocean

It has a surface area of **85 million km²**

FABULOUS FACT

Ice volumes

Arctic ocean
16 000 km³

Greenland
2 800 000 km³
That's 175x more than in the Arcti Ocean

Arctic populations

Sámi from Scandinavia

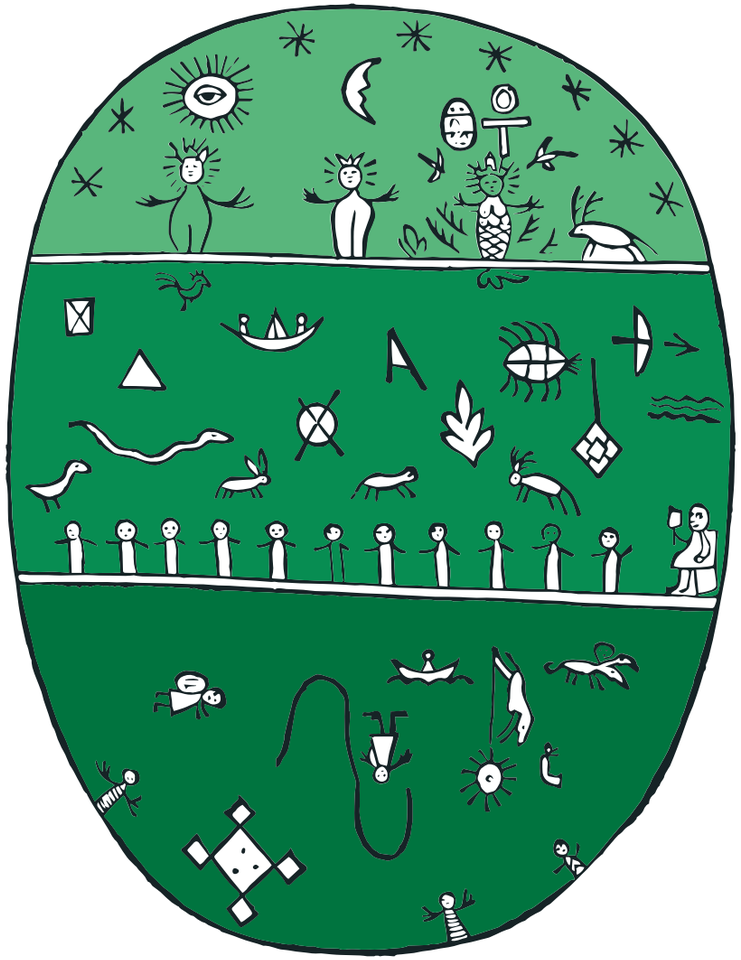
- There are approximately 4 million people living across the Arctic circle in total.
- About 40 different ethnic groups have lived there for thousands of years.
- There are currently estimated to be around 400,000 indigenous people, all having different cultures, customs and languages. They all share a strong bond with the Arctic and have a deep knowledge and personal connection to the natural world.
- Examples of indigenous tribes include:
  - the Inuits which occupy land in North America, Greenland and Siberia in Russia,
  - the Sámi live in the Scandinavian countries (Norway, Sweden, Finland) and Russia,
  - and the Nenets, Evenkis and Chukchi in Russia.

Nenets from Russia

DID YOU KNOW?

The Bering Strait between Russia and Alaska used to be a land bridge. The ancestors of the Inuits used it to migrate to North America between 6000 B.C. and 2000 B.C.

Arctic culture on the rise again



Sámi shaman drum illustrations

- For a very long time, indigenous groups have often been treated as inferior by non-indigenous people and even forbidden to practice their traditions.
- Today, many are standing up to restore their cultures and claim their rights to solve environmental challenges on their original land.
- Deforestation, pollution, natural resource exploitation, and climate disruption all cause a lot of damage to indigenous land in the Arctic Circle.

FROSTY FACT

Inuits build igloos only when hunting and can do so in less than one hour!

DID YOU KNOW?

Shamanism is the main Inuit's belief. There were many women shaman which shows the high value placed on females in their society.

FABULOUS FACT

The Most powerful shamanic gods are **Aakuluujjusi** goddess of creation and **Sedna** goddess of the sea.

Decipher this claim

- Many native Arctic populations in Russia use the Cyrillic alphabet to transcribe their languages and dialects.
- Can you work out this sentence below.

YE APE ПАРТ ОФ ТНЕ СОЛУТИОН БЕЦАУСЕ YE APE ЦОННЕЦТЕД ТО ОУР ЕНВИРОНМЕНТ.

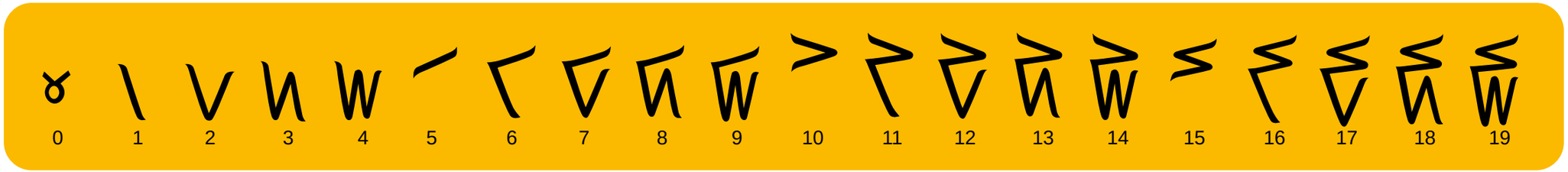
- Why do you think they say this?

A	А
B	Б
C	Ц
D	Д
E	Е
F	Ф
H	Н
I	И
L	Л
M	М
N	Н
O	О
P	П
R	Р
S	С
T	Т
U	У
V	В
W	Y

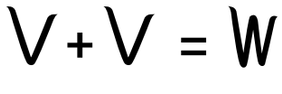
Class
Name
Surname
Date

Count like an Iñupiaq

- We count in base 10 (decimal system). We have 10 symbols (numerals) to write all the numbers 0 1 2 3 4 5 6 7 8 9. To write 10 we use the zero and the one.
- The Iñupiaq people, like the Mayan people of Mexico, count in base 20 because they use both hands and feet. They have 20 numerals.



- Their numerals are very clever as they add up graphically
- Can you complete the table?



Decimal	Iñupiaq
20	
21	
22	
23	
24	
40	
41	

Extension exercise

Decimal	Iñupiaq
40	
47	
50	
51	
80	
400	
416	

DID YOU KNOW?

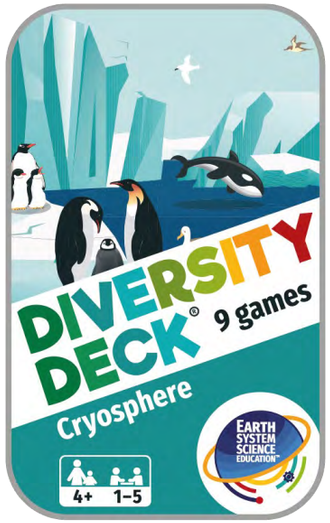
Iñupiaq are Inuits from Alaska, USA. Their language is threatened as it is spoken by only by **2000** People.

MATHS FACT

Sexagesimal system (base 60) was used by ancient Sumerians and Babylonians. It continues to measure time, angles, and geographic coordinates.

Competition

Sponsored by Junior JUNCTION



5 lucky winners will receive their own amazing Cryosphere DIVERSITY DECK® curtsy of Junior Junction

Please send a photo of your creation with your name and age to contact@maintenant.org.uk by the 31st August 2020. Have fun!

Design your own Arctic costume!

- Imagine you are an indigenous inhabitant such as an Alaskan or Greenlandic Inuit or Sámi from northern Norway, or perhaps imagine you are a sustainable fashion or textile designer, and you are inspired by the native dress of the Russian Nenets.
- Design your own costume using the template on the next page, or your own drawing! What would your costume look like? Use pens, pencils or scraps of paper and fabric.

- For inspiration, can you research some of the native or national dress the indigenous people wear and find out the costume's names?
  What would you call your creation?

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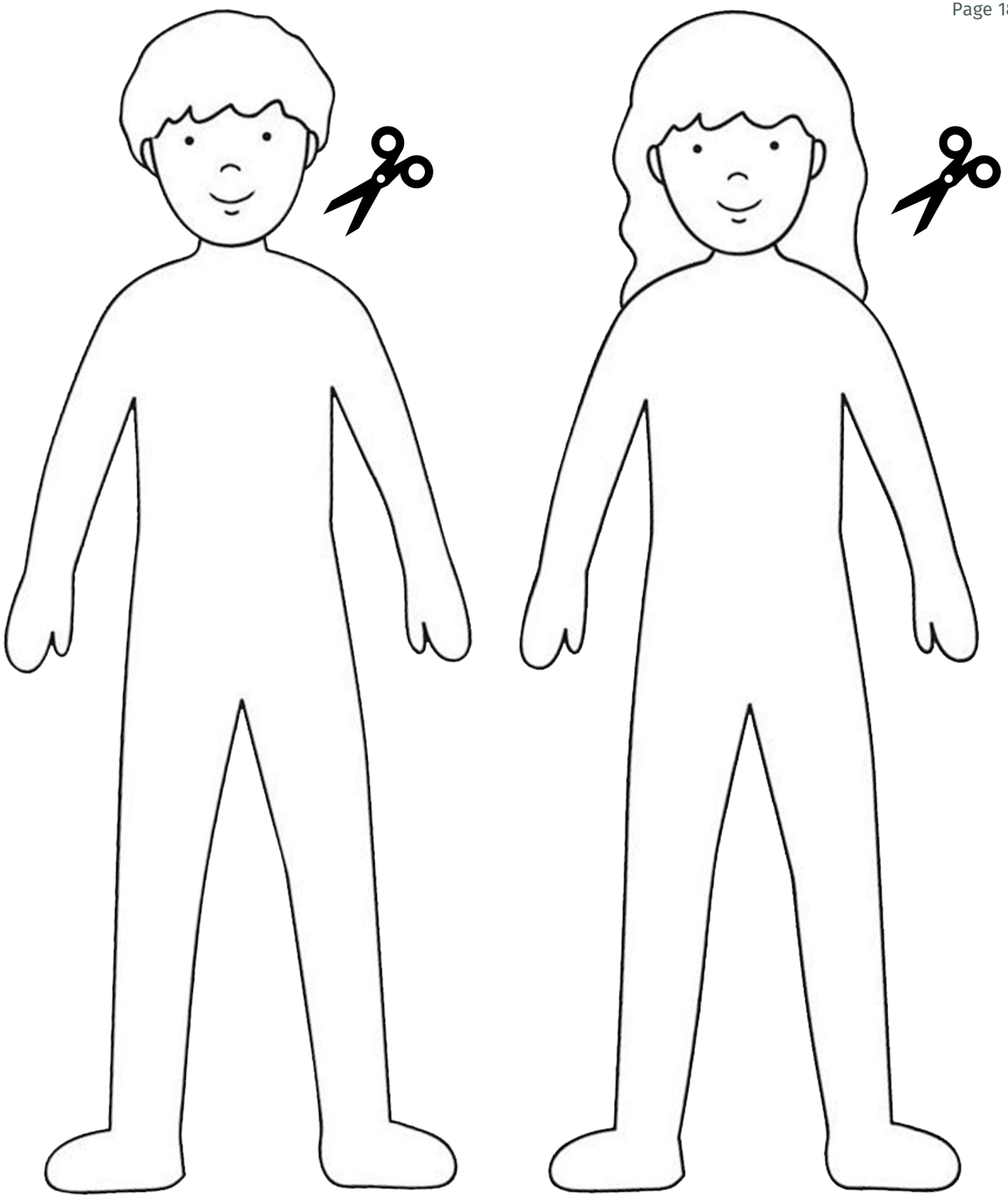
Competition

Sponsored by Junior JUNCTION

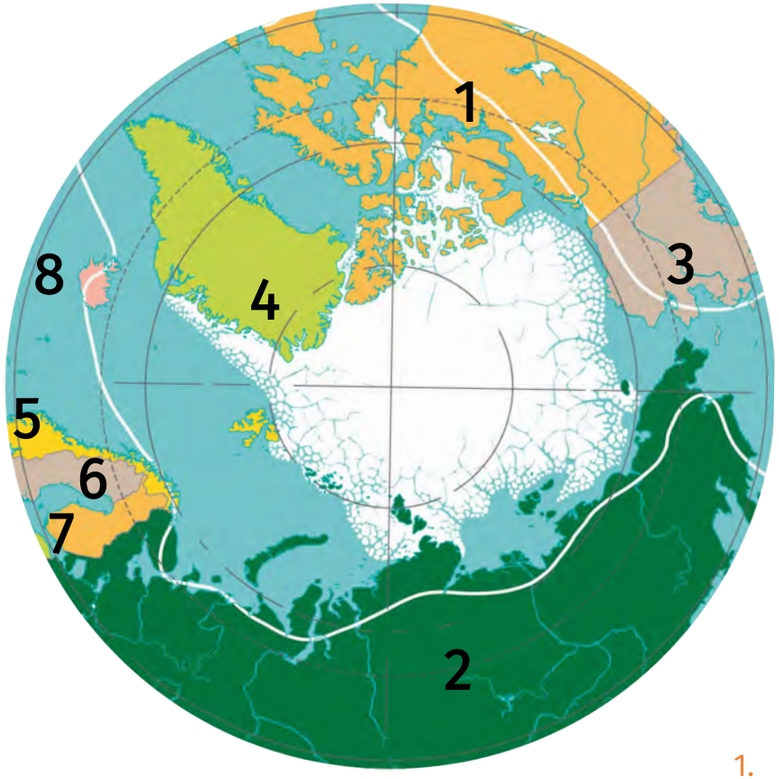
Here are some important things to consider when designing your costume:

- **Material**
  What type of materials are going to keep you warm and safe?
- **Colour**
  What colours are best to use for people living in cold climates?
- **Pattern and texture**
  What patterns and textures might there be in their environment that can inspire your costume?
- **Sustainability**
  How can you make your costume sustainable? This means causing little damage to the environment and nature



The Arctic Council

- Relationships and politics between all of these people plus the many indigenous groups are very important to ensure that sharing the resources within the Arctic Circle is fair.
- The Arctic Council is an intergovernmental organisation which promotes cooperation between nations and indigenous groups.
- It also reports on sustainable development and environmental issues in the region.
- However, it does not get involved in border or resource disputes between countries.



The Arctic (North Pole)

DID YOU KNOW?

There are 8 different countries in the Arctic Circle and this can make it difficult when countries try and exploit the Arctic for its natural resources and trade routes.

FABULOUS FACT

Arctic shipping traffic is expected to **quadruple** by **2025**

Arctic Circle

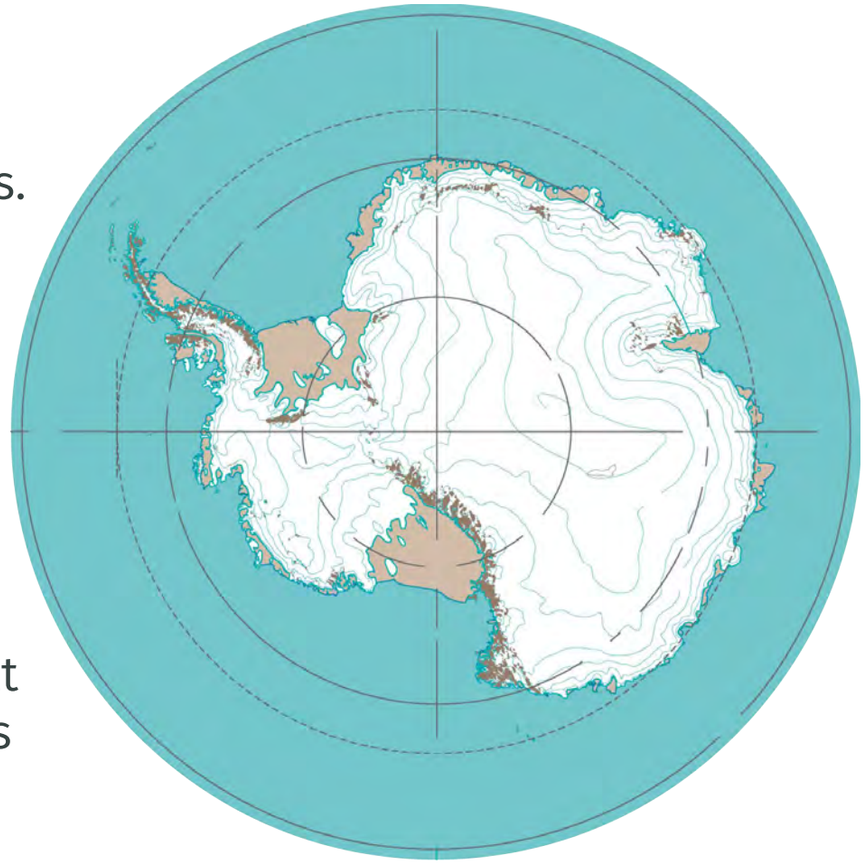
1. Canada
2. Russia
3. the USA
4. Denmark (Greenland)
5. Norway
6. Sweden
7. Finland
8. and a tiny part of Iceland

Trade route maze

- As the sea ice is melting in the Arctic, new trade routes for boats are being opened up and will become a motorway for shipping.
- Of particular concern is the increased risk of oil spills from oil tankers in the region and drilling for oil from large international corporations.
- Another important concern, is that the ships emit dangerous levels of carbon dioxide into our atmosphere, which is causing further ice to melt.
- Can you find a way through the broken and melting ice from Inuvik, Canada to Salekhard, Russia?

Antarctica - Ice on land

- Antarctica is a large continent surrounded by vast oceans.
- Every winter, the ice shelf which forms around Antarctica doubles the amount of ice found here.
- There is not one country which claims to own Antarctica.
- Instead, the Antarctic Treaty is an agreement between 52 countries that they will not exploit Antarctica for its natural resources and must ask for special permission to conduct scientific experiments and expeditions. It means Antarctica is dedicated to peace and science.
- This will leave the Antarctic as pristine and unspoilt as possible.



The Antarctic (South Pole)

FABULOUS FACT

Antarctica is covered in thick and deep ice sheets averaging **2 160 meters** thick! That's 22 Big Ben's on top of each other!

DID YOU KNOW?

90% of all the ice on Earth is found in Antarctica.

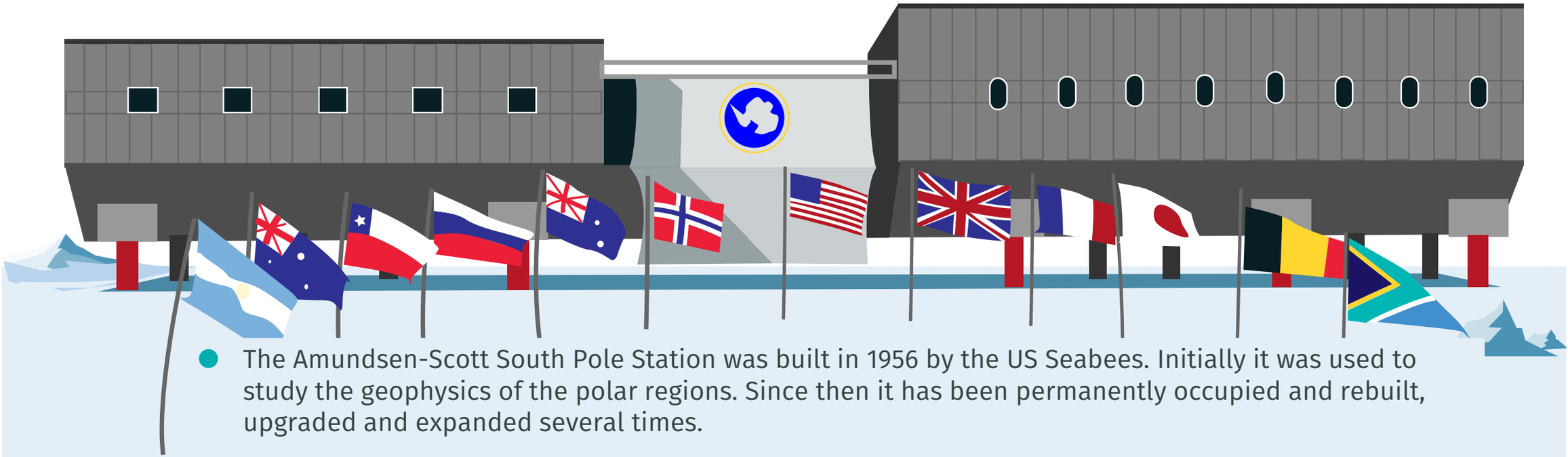
FROST FACT

Arctic comes from the Greek word Arktos which means **"bear"**

Antarctica comes from the Greek "opposite the bear" as it is at the opposite end of the planet.

Race to the South Pole

- The race to get to the South Pole was won by a party led by the Norwegian Roald Amundsen on the 14th December 1911.
- Robert Falcon Scott led a British expedition at the same time and reached the South Pole 33 days later on the 17th January 1912. Sadly, all 5 of the men on these expeditions died on their way back from a combination of starvation and cold. The amazing bravery and heroism of these men has been recognised by naming the large permanent research station at the South Pole after them.



- The Amundsen-Scott South Pole Station was built in 1956 by the US Seabees. Initially it was used to study the geophysics of the polar regions. Since then it has been permanently occupied and rebuilt, upgraded and expanded several times.
- It is the only building on Earth to have continuous sunlight for 6 months and then one equally long night. During the "night" the temperatures plummet to -73°C and there are extreme weather events such as blizzards and gale force winds. Despite these conditions, scientists endure them to study many fields of science including astrophysics, climatology, and geophysics.

Land of collaboration and scientific exploration

- Many explorations and experiments are undertaken every year on Antarctica and there are often as many as **4000 scientists** from over **60 countries** working there during the summer.
- Many do not have permanent structures to base themselves in and must use temporary huts which have to be dismantled and removed once the expedition is finished.
- Some explorers use specialist tents if they are only spending short amounts of time in different locations.
- Their specialist clothing is very important as it keeps them dry and warm. There are many different layers designed to keep warmth in and water out.

Antarctic explorers

- There have been many brave and heroic stories to come out of Antarctica.
- However, we would like to bring particular attention to Ann Bancroft and Liv Arnesen who have both achieved amazing feats and overcome the odds to the be the first females to cross Antarctica on foot in 2001.
- Since then, these two women have advocated for and inspired female explorers to follow in their footsteps and prove that anything is possible.

An Antarctic Explorer's Diary 1/2

- The following extract is from a diary written by geoscientists Dr. David Sugden from the University of Edinburgh and Dr Chris Fogwill from the University of Exeter during their Antarctic Expedition in 2007/08.

7th January 2008

Well, we finally got our weather window and moved into the Shackleton Range, now camped under Mount Skidmore overlooking the Slessor Ice Stream one of the major ice streams draining the centre of the East Antarctic Ice Sheet. It is an amazing change after the cold and strong winds of The Patriot Hills camp. We are now at a lower altitude and much closer to the Ronne Ice Shelf and as such the temperatures are warmer and as yet the wind has not materialised.

It was a great flight over, with clear views of the ice streams draining down into the Weddell Sea and of the Recovery Glacier to the south of the Shackleton Range. The huge and complex crevasses of the Recovery Glacier were particularly impressive, and made me think about the team that made the first traverse of Antarctica back in 1957 who crossed this glacier on route to the Pole. Thus getting its name from the numerous occasions it was required to recover their vehicles from the all to common crevasses. Suddenly I feel quite smug and safe, if a little unheroic being in a plane!

Arrival at our eventual destination was a shock, what on the aerial photos looked like soft snow turned out to be a thin hard packed layer of wind blown snow on top of blue ice! This was not at all suitable for camping on as in the event of a storm you can find all the snow being removed only leaving a layer of hard blue ice. So instead after a little explore we located a great flat spot down on the edge of a small ice lake formed at the edge of the ice sheet. We are camped on rock, in fact an old glacial till which has been left by the retreat of the ice sheet in this area. It provides an ideal base camp, with large stakes already left in place by a previous expedition who used this site sometime back in the 1970's.

Due to our delayed arrival work started straight away, with David describing the pattern of glaciation visible on the slopes of Mount Skidmore, making reference to the ancient preserved landscapes of the Dry Valleys on the other side of the Transantarctic Mountains in the Ross Sea Sector of Antarctica. Having never been there personally I could only listen and learn, but the differences between these mountains and the other mountains I have seen in Antarctica is stark.

The key to understanding how the ice sheets have changed here is to survey the presence of glacial erratics, which are composed of different types of rocks than those that outcrop locally. Even from our first surveys we can see variations with altitude, which once constrained by detail, survey and sampling will allow us to reconstruct the history of the ice sheet in this sector of Antarctica.

A glass of wine in the sun before bed, with our second flight coming tomorrow it is critical we collect as many samples as possible to make the most of the empty plane on the return flight!

An Antarctic Explorer's Diary

2/2

Questions

1. Is the weather better or worse in the Shackleton Range than The Patriot Hills Camp? Why do you think that?

2. Why does the author feel "unheroic" for being in an airplane?

3. What three things made the campsite so perfect?

4. What will they do to reconstruct the history of the ice sheet they are studying?

5. Why do you think he made reference to the Sun still being up as it was time to go to bed?

You can read more of this diary at [The School of Geosciences of The University of Edinburgh's website]
The following day, there was quite a dramatic accident!

Arctic flora

- Throughout the Arctic Circle, the wide-open landscape is called Tundra and is recognisable by having no trees. The short growing season and low temperatures prevent them from growing.

DID YOU KNOW?

The term Tundra is Russian and comes from the Kildin Sámi word тӯндар meaning "uplands", "treeless mountain tract".

Arctic plants are adapted to the freezing conditions

1. They need less water, less sunlight and less nutrients than plants in other parts of the world.
2. They are rarely higher than 15cm and grow close to the ground so that they can withstand the heavy winds full of ice and gravel.
3. The underlying ground is frozen which means that roots cannot grow into it. This frozen ground is called permafrost.
4. Their short roots mean they can only reach limited water and nutrients.
5. Most of the year they remain dormant, however, once the short summer begins in June, they grow quickly; powered by the sun which never sets.

Treeless and colourful tundra

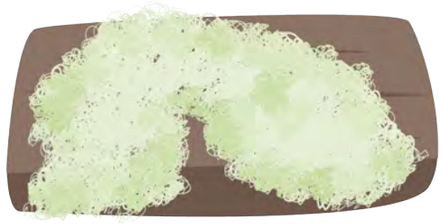
- The Arctic ecosystem is very rich but also very vunerable to change.

Arctic Willow

The northernmost woody plant in the world is a small shrub with hairy flowers.

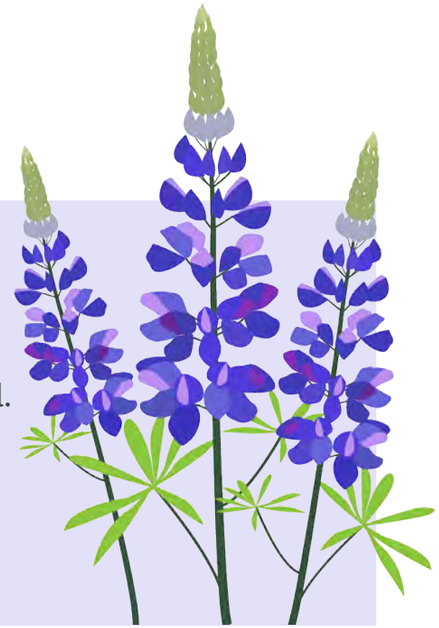
Reindeer lichen

It grows slowly but steadily in Canada and Scandinavia. Reindeers and musk oxen enjoy eating them.



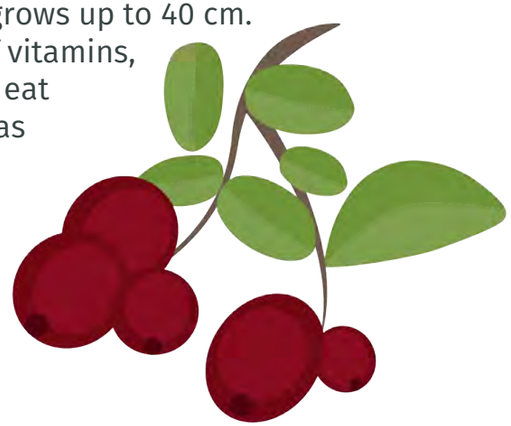
Arctic lupine

It is eaten by Arctic hares and ground squirrels and grows up to 50 cm tall.



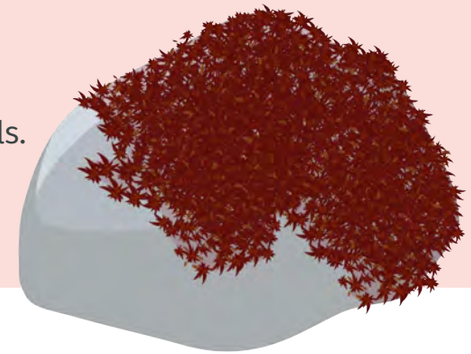
Lingonberry

Grows poorly when hot, but thrives in extreme cold and grows up to 40 cm. It is full of vitamins, is good to eat and used as medicine.



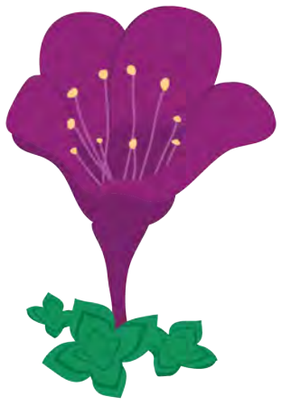
Peat moss

It is a superabsorbent moss used as a soil conditioner, insulator or a friendly alternative to chlorine in swimming pools.



Purple saxifrage

One of the first plants to flower in the Arctic spring can also be found in the Alps and the Rocky Mountains.



Antarctica frozen desert

- The Antarctic Continent is the coldest, windiest and driest place on Earth.
- Snow permanently covers 99% of the continent making it the largest desert on Earth.
- It is classed as a desert because of the low amounts of snowfall per year. The air is extremely dry and when snow does fall, it does not melt but instead it builds up the ice sheet which covers Antarctica. Although it contains more than 60% of the world's fresh water, none is available to life as it is locked in the ice.
- The low precipitation is because the air is too cold to hold water and has low humidity.

DID YOU KNOW?

Humidity describes the amount of water vapour in the air. This increases the likelihood of rain.

The most humid places on the planet are in tropical regions near the equator

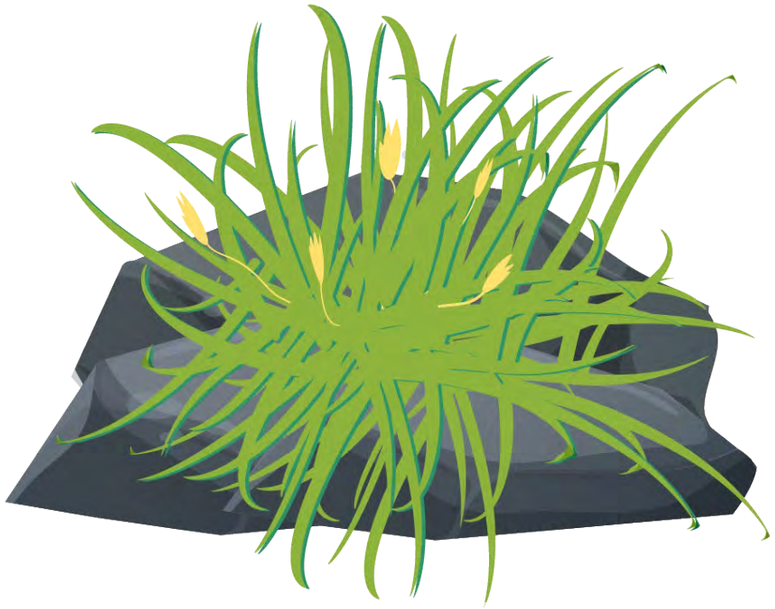
FROSTY FACT

Large parts of the land inside the Arctic circle are also classed as a desert.

Antarctic melt has tripled in the last decade.

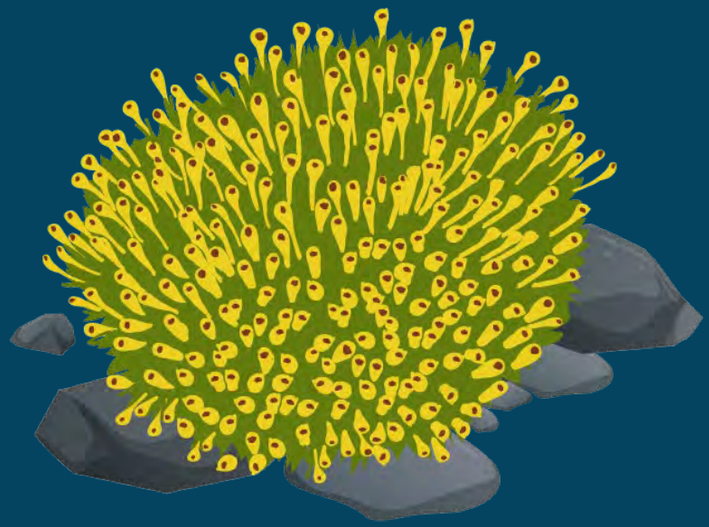
Lichens, mosses and 2 flowering plants

- There are about 250 varieties of lichens, 100 species of mosses, and 700 types of marine and non-marine algae which flourish in Antarctica.
- There are only 2 flowering plants:



Antarctic Hair Grass

The southernmost flowering plant. It grows between rocks and thrives thanks to warming temperatures.



Antarctic Pearlwort

About 5 cm high, compact low-growing plant. It resembles a moss with yellow flowers.

DID YOU KNOW?

Plants cover
less than 1%
of Antarctica but they are becoming more abundant due to global warming.

FROSTY FACT

The coldest temperature to have been recorded on Earth was
-89.2° C
in Vostok Station, Antarctica in 1983.

Other permafrost flora

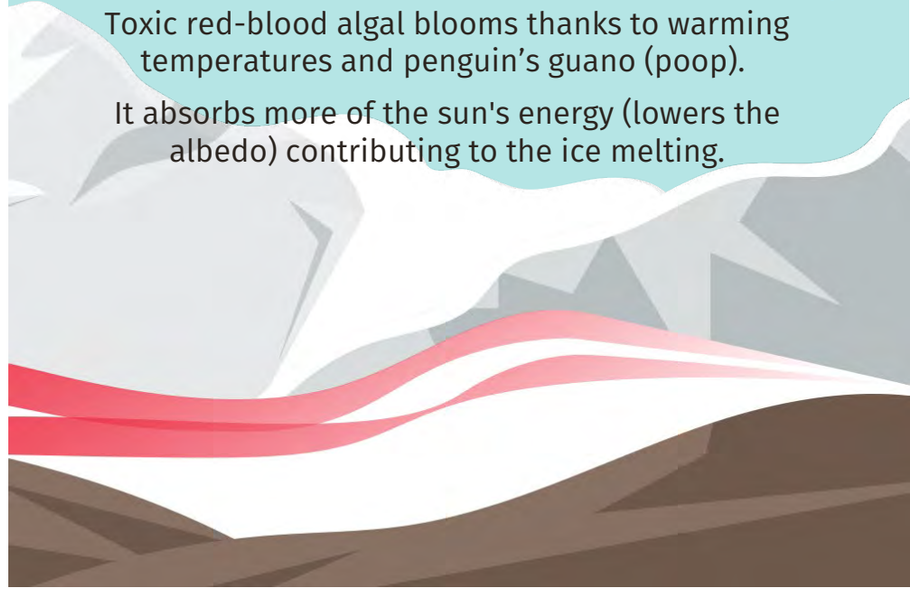
Lichens

- Lichens are incredible as they are a mutualistic relationship between fungi and algae, working together and helping each other survive. Different lichens are found all over the world.
- Lichens get their water by absorbing it from the surrounding air and although they are not plants, they photosynthesise to produce food.
- They are important because they
  - are at the bottom of many food chains,
  - contribute to soil formation,
  - convert nitrogen in the air into nitrates in the soil which are crucial for healthy plants.
- They are very sensitive to air pollution and are used as an indicator of air pollution severity around the world.
- Scientists in Antarctica have been studying them to indicate changes in the local climate.

Red Snow

Toxic red-blood algal blooms thanks to warming temperatures and penguin's guano (poop).

It absorbs more of the sun's energy (lowers the albedo) contributing to the ice melting.

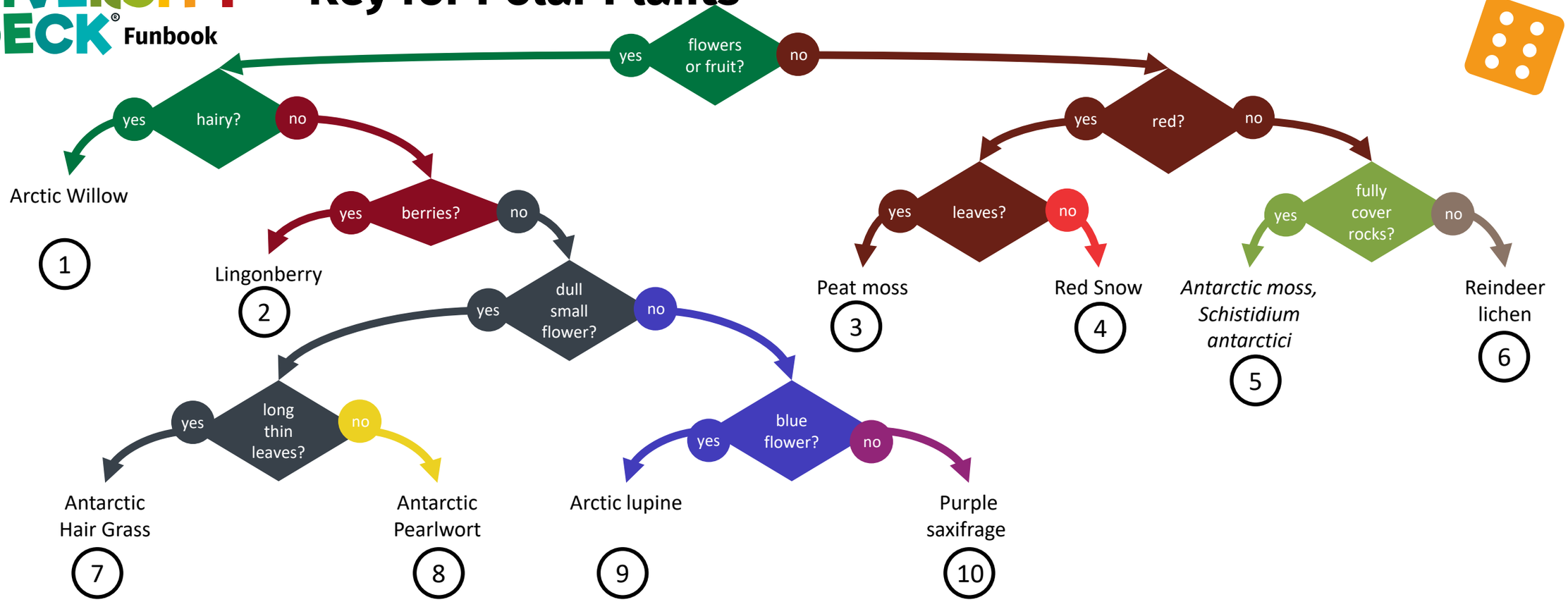


Antarctic lush moss forests

The most common moss, *Schistidium antarctici*, forms **a green carpet** on rocks and soil in East Antarctica.
It thrives in freezing conditions
but does not do so well when it is warm.

DIVERSITY DECK® Funbook

Key for Polar Plants



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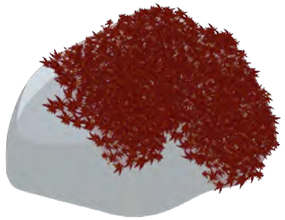
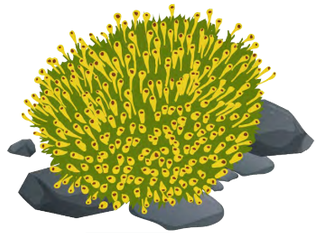
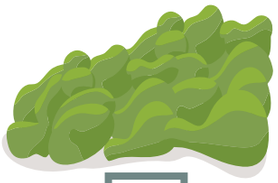
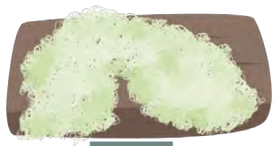


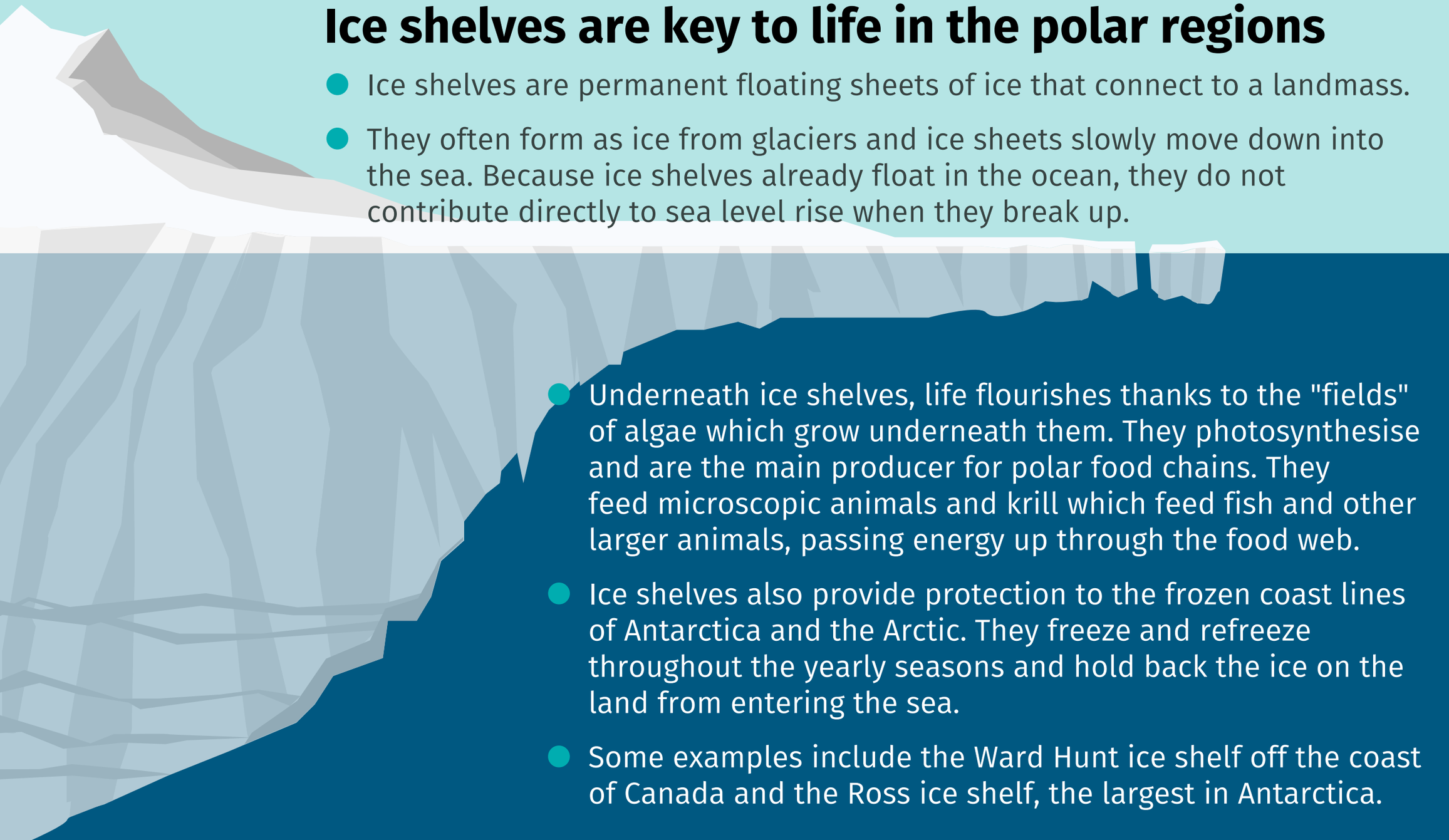






Ice shelves are key to life in the polar regions

- Ice shelves are permanent floating sheets of ice that connect to a landmass.
- They often form as ice from glaciers and ice sheets slowly move down into the sea. Because ice shelves already float in the ocean, they do not contribute directly to sea level rise when they break up.



- Underneath ice shelves, life flourishes thanks to the "fields" of algae which grow underneath them. They photosynthesise and are the main producer for polar food chains. They feed microscopic animals and krill which feed fish and other larger animals, passing energy up through the food web.
- Ice shelves also provide protection to the frozen coast lines of Antarctica and the Arctic. They freeze and refreeze throughout the yearly seasons and hold back the ice on the land from entering the sea.
- Some examples include the Ward Hunt ice shelf off the coast of Canada and the Ross ice shelf, the largest in Antarctica.

Arctic fauna – Animals of the Arctic

The rich and diverse Arctic ecosystem is full of surprises.

- The Arctic Circle welcomes back large numbers of migratory birds every spring who flock there to breed and take advantage of the great fish stocks in the Northern Oceans.
- The Arctic has many very large land mammals including the world's largest land carnivore, the Polar Bear and the world's largest deer, Moose.
- Under the waves. The Arctic Ocean has recently revealed a big secret!
  It has very large coral reefs which support a huge range of biodiversity. Among them are sponges, clams, crabs and lobsters and many other invertebrates. They also have the important job of providing a nursery environment for many deep-sea fish.

FROSTY FACT

A walrus can eat
4000 clams
in one sitting!

Antarctic fauna – Animals of the Antarctic

- The most striking thing about Antarctic fauna is that there are no land mammals, reptiles or amphibians and very few birds.

- Most animals are adapted to live in the oceans, which is probably because the ocean temperatures are much warmer than the land; between -2°C and 10°C.

- There is only one insect, the Antarctic midge which is the continent's only fully land animal!

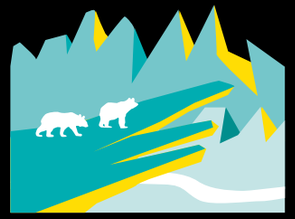
The lithosphere is changed by the cryosphere

- The lithosphere, or the Earth's crust, is constantly changing over time. Erosion is the process by which wind, water and other natural processes change rocks.

  - **Glaciers** are so heavy and create such large forces and pressures that they change the lithosphere by carving out huge valleys or physically pushing the tectonic plates down under their weight.

  - **Permafrost** is an underground layer of soil, gravel and sand which is frozen for more than 2 years at a time. Much of the Arctic Circle is covered in permafrost which can reach from just a few centimeters to 1,500m into the Earth's crust.

  - Not much is known about the permafrost in Antarctica as it is covered in such a deep ice sheet, it is difficult to take measurements of ice beneath the ground.



Glaciotectonics

Glaciotectonics is the study of changes to tectonic plates under the pressure of the glaciers. Scientists study the distortion and erosion of the crust made from glacial ice and make predictions of ice movement.

FABULOUS FACT

25%

of the Northern Hemisphere is covered in permafrost.

DID YOU KNOW?

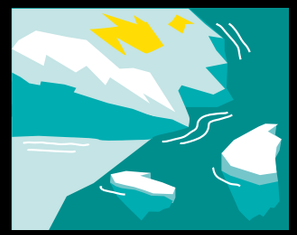
There are many viruses locked within permafrost which could cause disease if thawed and released into the environment.

FROSTY FACT

Nearer the North Pole, some of the Arctic Ocean floor is also permanently frozen. This is called **subsea permafrost**

What is the difference?

- **Ice-cap** – an expanse of ice covering a large area of land but less that 50,000 km2 (this is roughly 2 and a half times the size of Wales)
- **Ice sheets** - a covering of snow and ice across a large land mass greater than 50,000km2.
- **Permafrost** – frozen soil which can extend from between 3 cm to 1500m beneath the earth's surface.
- **Ice shelves** - A floating sheet of ice which is attached to a continent.
- **Slush puppy** - unhealthy snow where huskies live.
- **Glaciers** - a very slow moving river of ice which has been formed from snowfall and ice accumulation over many years.
- **Snow** - frozen water vapour which falls to earth as white flakes of ice.
- **Icebergs** – a large floating mass of ice which has detached from an ice-sheet or glacier.



Glaciomorphology

Study of the different types and forms of glaciers. Analysis of how weather (temperature and wind) and climate change influence their evolution.

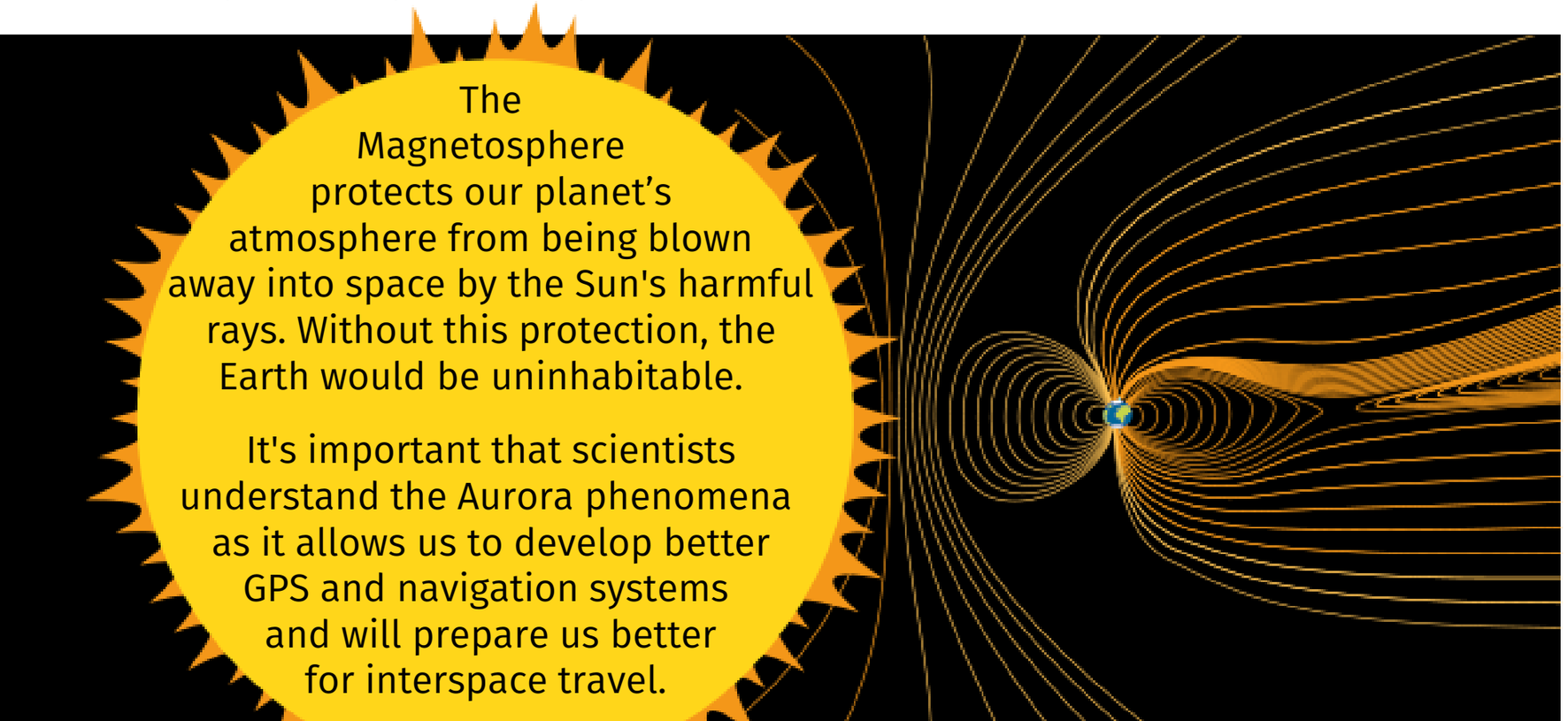
One word and definition is out of place.
Can you guess which one?

Aurora in the night sky are created by the magnetosphere

- Auroras are amazing spectacles that appear in the night sky.
  - Northern Lights (Aurora Borealis) in the North Pole
  - Southern Lights (Aurora Australis) in the South Pole
- They have mystified the people who live there for thousands of years.
- It was only 150 years ago that scientists began to understand them and only recently that they unearthed their secrets.

DID YOU KNOW?

Polaris is the star nearly directly above the North **Pole** in the Arctic. It is also known as the "**North Star**".



FABULOUS FACT

The Earth's magnetosphere is approximately 65,000 km above us on the side of the planet facing the Sun?


Aurora in the night sky are created by the magnetosphere

Increased GHG* in the atmosphere cause the Earth to warm

- Global temperatures are rising because of an increase in carbon emissions globally and the cryosphere is warming three times quicker than the rest of the planet.
- Two thirds of GHG's are caused by humans burning fossil fuels such as coal, oil and gas in homes and power stations. This sends carbon dioxide and other GHG's up into the atmosphere. These gases absorb heat from the sun and trap it, warming up the atmosphere, oceans and planet. This is called **global heating.**
- To keep global warming within safe limits (limiting global warming to 1.5°C above pre-industrial levels) we need to reduce our carbon emissions by ½ every decade so that they reach zero by 2050.
- Earth's global temperature in 2016 was the highest, and in 2019 was the 2nd warmest since modern records began in 1880. It is around 1 degrees Celsius warmer than 1951-1980.

CLIMATE FACT

The past 5 years have been the warmest of the last **140 years.**

DID YOU KNOW?

There is a direct link between increased industrialization, which began **150 years ago,** and the increase in global temperatures.

FROSTY FACT

Many glaciers around the world are melting because of global heating. Scientists call it **Glacial Retreat.**

* GHG = Greenhouse Gases

Global heating debate

If you are completing this in schools, divide the class into groups and

- ask half to research and argue FOR global heating being caused by humans
- and ask the other half to research and argue AGAINST global heating being caused by humans.

- Sometimes scientists have disagreed about global heating. Some don't believe there is enough evidence to say that it is caused by humans.
- More recently, the evidence has been mounting and now **it is undeniable that emitting GHG's into the atmosphere does cause global heating.**
- However, some world leaders and large corporations who stand to lose from reducing these emissions still try to argue otherwise.
- You will need to use computers to research and find facts and evidence for your debate.

* GHG = Greenhouse Gases

When debating, "arguing" is not enough to win, you have to be able to incorporate the following skills into your speech.

- **Reasoning and evidence**
  Turn evidence and facts into strong reasons for people to agree with you.
- **Expression and delivery**
  Deliver your speech in a clear and interesting way which will make people want to listen to you and agree with you. This means using a clear and interesting speaking voice.
- **Listening and responding**
  The other side of the argument will need to be listened to carefully so that you can respond and disagree with them clearly with relevant evidence and facts.
- **Organisation and prioritisation**
  Organising everything that you need to say into a clear message that makes sense and includes everything that you want to say.

The cryosphere is a subset of the hydrosphere

The cryosphere is sometimes included as part of the hydrosphere but because it has such enormous implications for the future of our climate, we believe it is one of Earth's most important spheres!

FROSTY FACT

The temperature at which a solid turns to a liquid is called the melting point. Ice melts at 0°C.

The cryosphere acts as an air conditioning system on planet Earth, helping to regulate its temperature. As ice melts seasonally, cold water is circulated through the hydrosphere using ocean currents. In turn, this cools water and maintains the planet at a perfect temperature to sustain life.

Because of global heating, there is more ice melting for longer during the summer in the Arctic Ocean. This then creates a lower albedo (see following page) for the planet and more heat is now being absorbed into the polar waters.

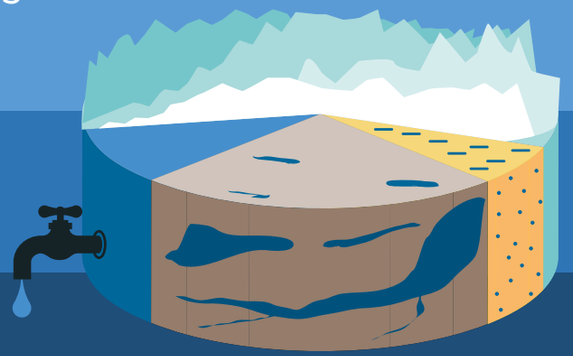
FROSTY FACT

68%

of all the fresh water on Earth is found in the cryosphere.

Scientists now believe that this heat is spreading across large areas of land such as Greenland. These ice-sheets are melting and running off into the Arctic Ocean. This warmer water causes more sea ice to melt.

In addition to the extra water which is added to our oceans from the ice sheets melting, as water heats, it expands. Both of these cause sea levels to rise.



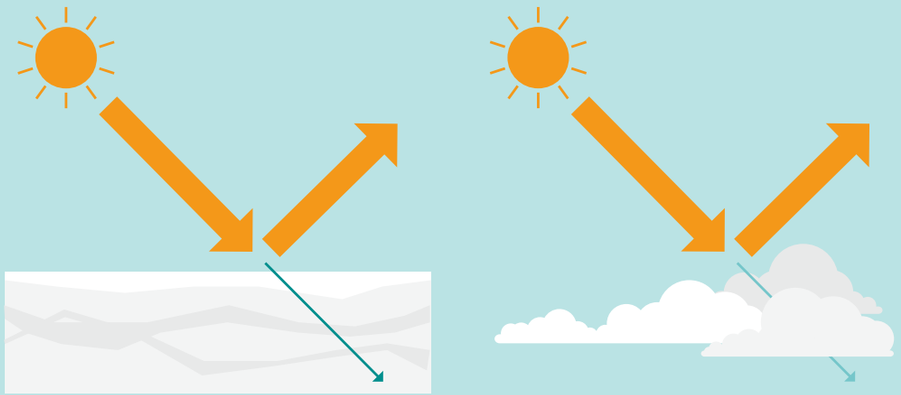
Albedo

- Albedo is the amount of light or sun's radiation which is reflected from an object's surface.

High albedo

Surfaces reflect a lot of the sun's energy

➔ so they cool down.

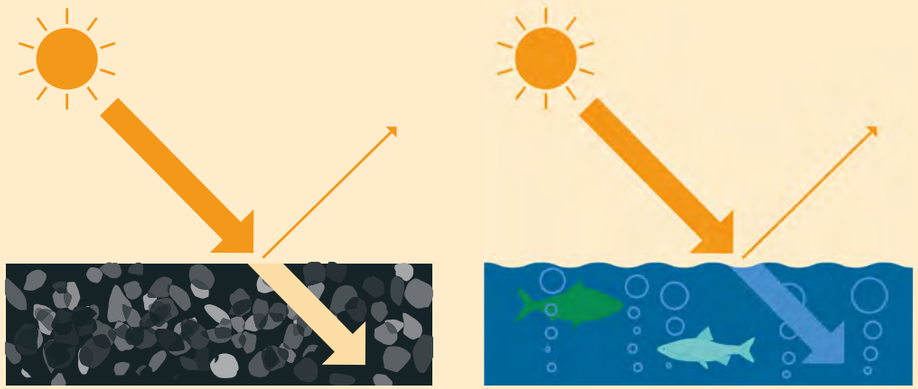


80-90% sunlight reflected

Low albedo

Surfaces absorb more of the sun's energy

➔ so they heat up.



10-30% sunlight reflected

The ice in the cryosphere creates a high albedo

- The white ice in the Cryosphere creates a high albedo for our planet as it reflects a large amount of the Sun's energy (solar radiation) back into space, keeping the planet at a temperature suitable for life.
- As it melts there is less white ice across the north and south pole which reduces the planet's albedo.
- More of the Sun's heat and light is absorbed by the planet causing the Earth to warm up still further, adding to the global heating effect from greenhouse gases.

DID YOU KNOW?

Touareg people in Northern Africa wear white and indigo blue flowing robes to reflect the heat of the Sun and keep them cooler in the intense heat.

SPACE FACT

Enceladus the 6th largest moon of Saturn, is mostly covered by ice, making it very reflective. It has the highest albedo in our Solar System:

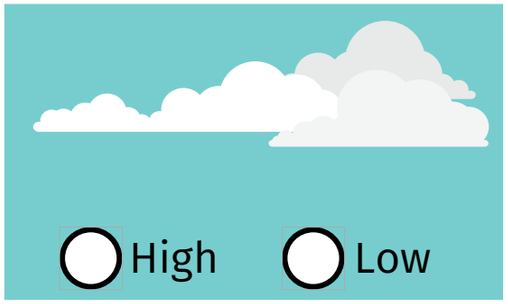
99%

Guess my albedo

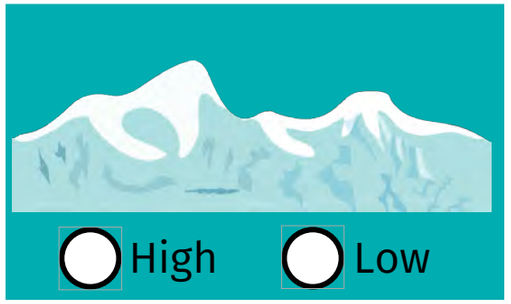
- Which of the different surfaces below have a high or low albedo?
  - **High albedo** means that they reflect a lot of the sun's energy and cool down.
  - **Low Albedo** means that they absorb more of the sun's energy and heat up.

○ High ○ Low

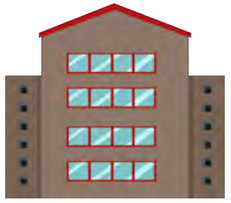
○ High ○ Low



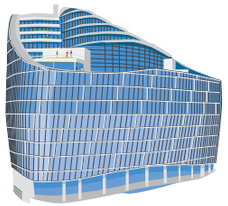
○ High ○ Low



○ High ○ Low



○ High ○ Low



○ High ○ Low

Extension question

Red Snow

A toxic algal bloom turning snow red.

○ High ○ Low

What do you think is happening to the ice underneath?

_____

You feel cooler with a white t-shirt

White has a high albedo and reflects light and heat.

TRY IT OUT

Stand outside on a sunny day in white clothing and then dark clothing or have 2 children wear different clothes at the same time. Compare the temperatures of their clothes.

You feel warmer with a black t-shirt

Black has a low albedo and absorbs light and heat.

Ice cores tell the story of the atmosphere

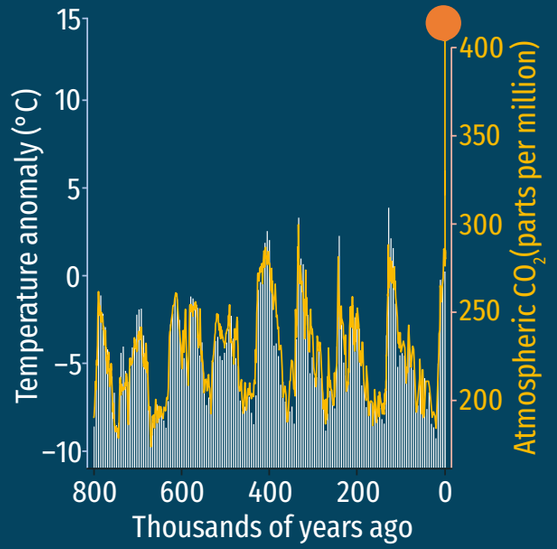
- Ice cores allow us to go back in time and study old climates. It is like reading the rings of a tree and each layer represents a year's snowfall.
- Analysing the chemicals found in these layers allows scientists to read the ice core like Earth's geological history book.

FROSTY FACT

Lake Vostok is

4000m

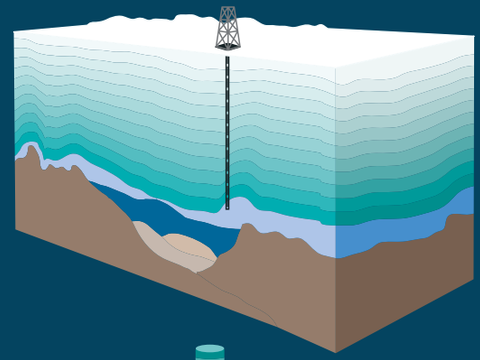
below Antarctica and the world's deepest subglacial lake.

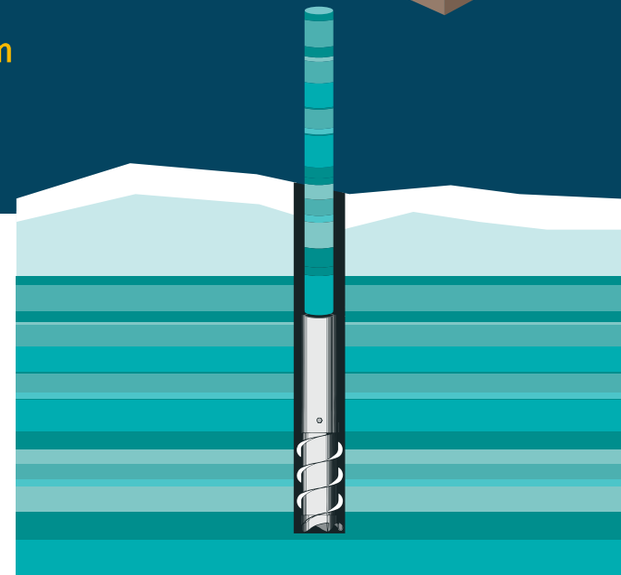


A group of scientists took a 400,000 year ice core in Lake Vostok, Antarctica and another ice core was taken from another site called Dome C which gives information from the past 800 000 years.

They found that carbon dioxide in the atmosphere is at its highest levels for at least 800,000 years!

Industrial activities that modern civilization depend upon have raised atmospheric carbon dioxide levels from **280 ppm** (parts per million) to **412 ppm**, in the last 150 years alone.





Glaciochemistry

In the cryosphere, paleoclimatologists use glaciochemistry to analyse the chemistry of ice cores to tell us what the atmosphere was like through the ages.

Case study: ancient rainforest in Antarctica

- An international team of researchers in the Antarctic have recently made an astounding discovery! Scientists have uncovered the remnants of a **90 million year old** rainforest in an ice core from the seabed just off of the coast of West Antarctica.
- This rainforest leads scientists to believe that the Earth was warmer and had more carbon dioxide in the atmosphere than previously thought! They have also calculated that the forest would have had a similar rainfall to Wales at that time.
- This discovery also shows how important the ice on Earth is at providing a cooling effect. Because there was no ice at the south pole, they discovered that the climate at the time was much warmer than they had previously thought.

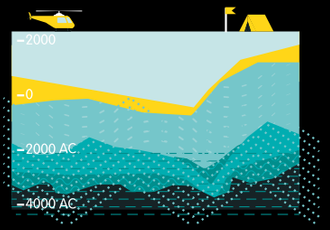
DID YOU KNOW?

The average temperature of the rainforest would have been

12°C

FABULOUS FACT

The team identified roots, spores and pollen in their sample and could even identify that they came from conifers and ferns. It was like doing a ginormous jigsaw.

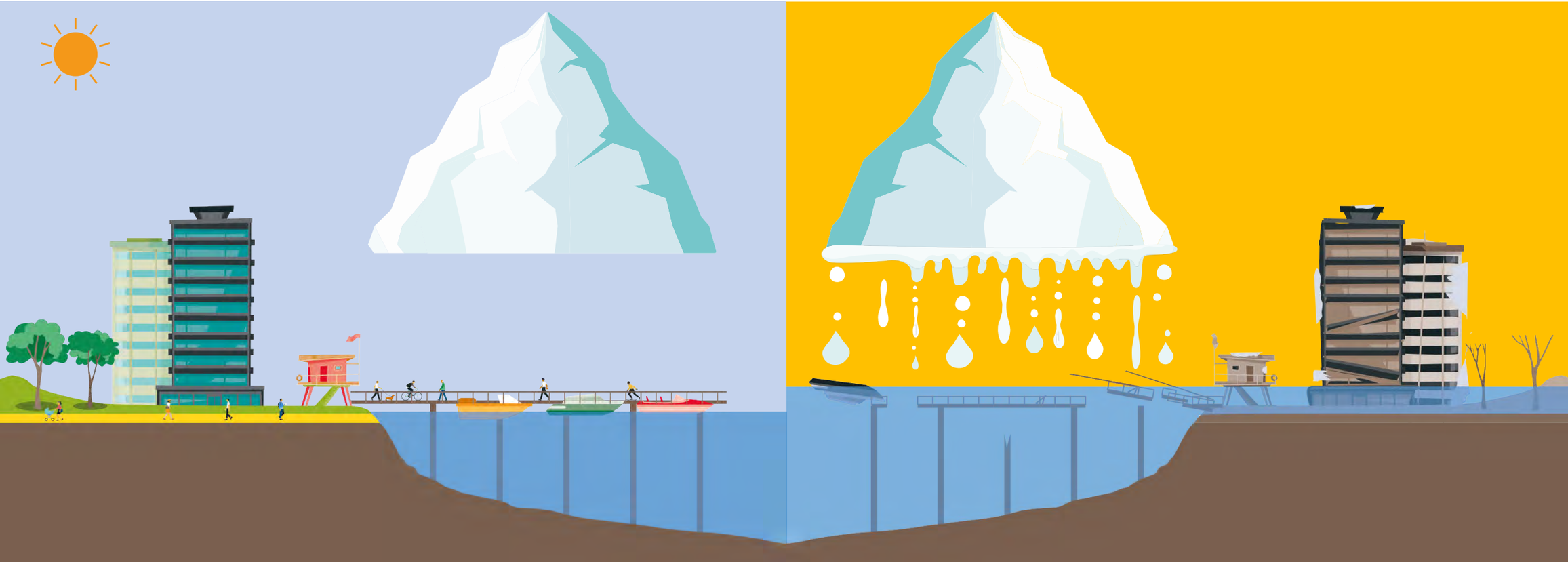


Paleoglaciology

Science of the glaciers' dynamics and evolution throughout geological eras. Understanding the glaciation periods to improve climate forecast.

The consequences of ice melting

- As ice on land in the cryosphere melts it contributes to sea levels rising. This will cause flooding to coastal towns and cities around the world.
- Scientific projections indicate the resulting sea level rise could put 400 million people at risk of annual coastal flooding by the end of the century as sea levels will have risen by 71cm.
- These cities must adapt and become more resilient or move and be rebuilt elsewhere.
  - There are already plans underway for Indonesia's capital, Jakarta, to move to the neighbouring island of Borneo.



Sea levels rising

- Observations from satellites monitoring Greenland and Antarctic ice sheets have shown they are losing ice 6 times faster than they were in the 1990s.
- Scientists are worried about 3 massive ice sheets melting which would contribute to sea levels rising globally.

West Antarctic ice sheet

would add **5** metres

~ height of a double decker bus

Greenland ice sheet

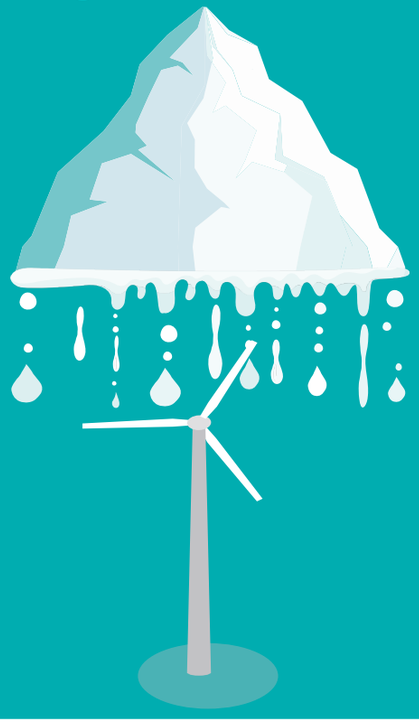
would add **7.3** metres

~ height of a large giraffe

East Antarctic ice sheet

would add **53** metres

~ height of a wind turbine



FABULOUS FACT

Global sea levels have risen by about **20cm** since 1901

DID YOU KNOW?

NASA estimate **49 000 gigatons** of ice have melted since 1901. It's enough to coat the entire moon's surface in a 1.5m ice sheet!

FROSTY FACT

All the ice melting from the Arctic and Antarctic Ocean will only contribute to sea levels rising a tiny amount because the ice is already in the water.

Sea ice melting

- Sea ice creates a higher albedo for our planet. Without it, the planet begins to heat faster causing more sea ice to melt.
- Ocean temperatures increase which causes sea levels to rise from thermal expansion.
- Animals which rely on the sea ice have to change their behaviours and risk the chance of dying and going extinct.
- Ice shelves and sea ice melting will reduce the production of the algae at the base of the polar food webs and there will be a lack of food to feed the biodiversity in these regions.
- Ice shelves protect ice on land which may collapse into the sea without them.

Mountain glaciers melting

- They act as flood protectors and lock up 24 million cubic kilometers of water keeping sea levels constant and protecting coastal cities.
- Many glaciers found in high mountain ranges provide a supply of water during the summer months to large and important rivers.
- Rivers provide water for farmers to irrigate their crops, fresh drinking and bathing water and food from fish and other edible river creatures.
- Without the glaciers to feed the rivers, they will possibly dry out and only be replenished by rainfall. This will lead to terrible consequences such as drought and famine.

Permafrost thawing

- Permafrost in the Arctic Circle is melting at a rate which is alarming scientists.
- It is important that the permafrost stays frozen as it holds a lot of fresh water and greenhouse gases.
- As the permafrost thaws, it loses water into oceans which raises sea levels and also releases harmful greenhouse gases into the atmosphere, further heating of the planet occurs which melts more ice and permafrost.
- A dangerous feedback loop is created.

We still have time to reverse this trend if we adopt a more sustainable lifestyle!

The consequences of global heating on sea levels

- Can you fill in the blanks using the words below?

_____ _____ are emitted into the atmosphere from burning fossil fuels and permafrost melting.

A blanket of greenhouse gas in the atmosphere traps heat and warms the _____.

Feedback loop

___ _____, glaciers and permafrost melt.

Feedback loop

Albedo is reduced so more of the Sun's _____ is absorbed by the planet.

Sea temperatures _____.

As water heats up, it _____, further adding to sea levels rising.

___ _____ rise.

- ☐ energy
- ☐ expands
- ☐ Greenhouse gases
- ☐ Ice sheets
- ☐ increase
- ☐ planet
- ☐ Sea levels

As the Earth heats up, ice around the globe is melting with serious consequences.

Once the cryosphere has warmed and melted too much, a **tipping point** will be reached where we cannot save it.

The Earth will continue to heat, the cryosphere will melt and sea levels will rise.

Polar ice experiment

- A simple experiment to demonstrate how melting ice caps and ice sheets effect sea levels and animal life in the Cryosphere.

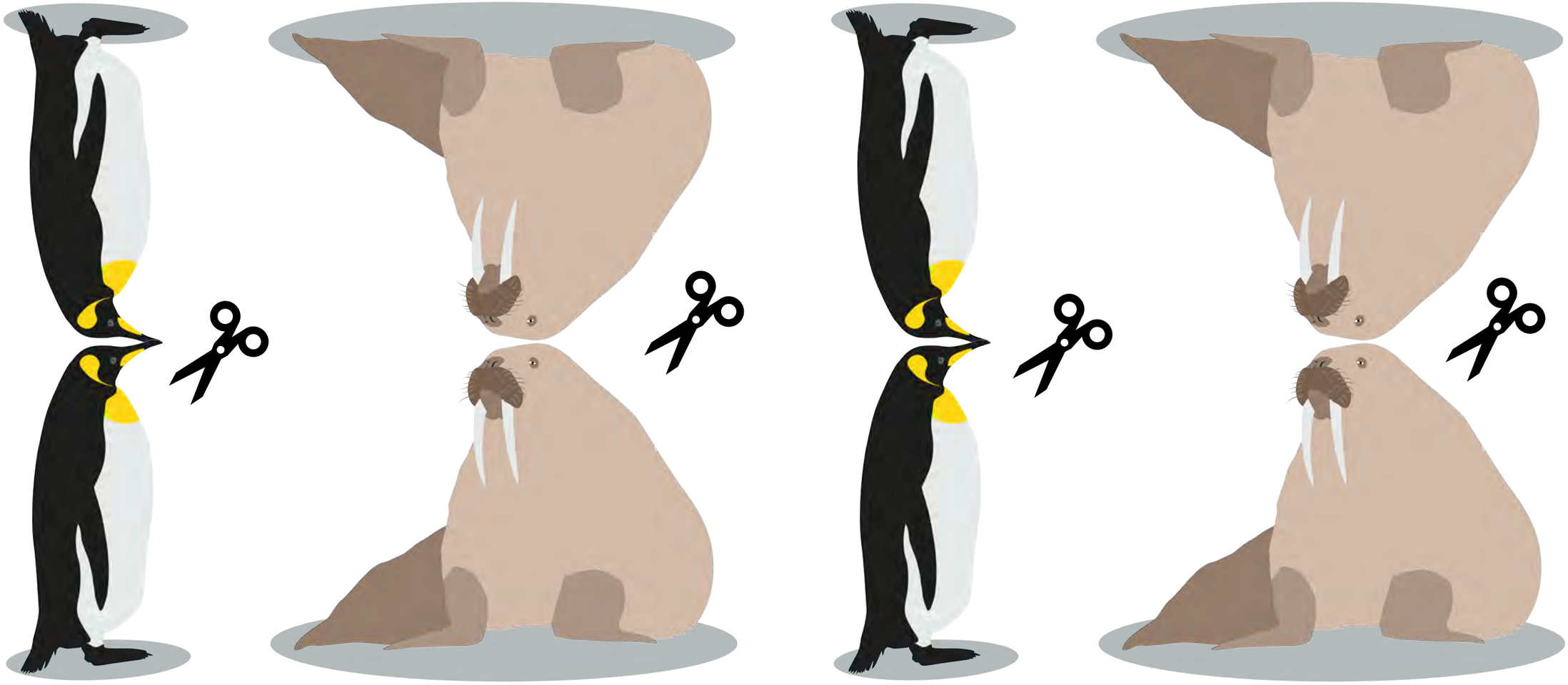
You will need

1. A plastic or metal storage container
2. Water
3. Blue food colouring (for fun!)
4. Pebbles / stones
5. A ruler
6. A timer
7. Icebergs - you will need different sized plastic bowls
8. Polar animal figures such as penguins, seals, narwhals, polar bears, whales.
   If you don't have polar animal figures you can cut out the ones on the next page and then stick to milk bottle lids!

Polar ice - preparation

The day before your experiment

- Fill the bowls with water and place carefully in the freezer to freeze overnight.
- Cut your animals. Fold them in two. Stick them on a plastic lid.



Polar ice experiment - instructions

1. Arrange stones and pebbles on one side of the container
   ➔ represents Greenland or Antarctica
2. Fill the container with about 1cm of water.
3. Mix blue food colouring into the water
   ➔ represents the oceans surrounding Greenland and Antarctica
4. Remove the frozen icebergs from the bowls and place some on the stones
   ➔ represents the ice sheet on Greenland and Antarctica
5. Place the other icebergs directly into the water
   ➔ represents the icebergs and caps in the ocean
6. Add your polar animals to the ice, water and stones. Record the time you start your experiment.
7. Using the ruler, take you first water level measurement and record your result.
8. Use the timer and ruler to measure the water level every 20 minutes, until the ice has melted, and write down your results. Take note of what happens to the ice in the water and ice on the land.

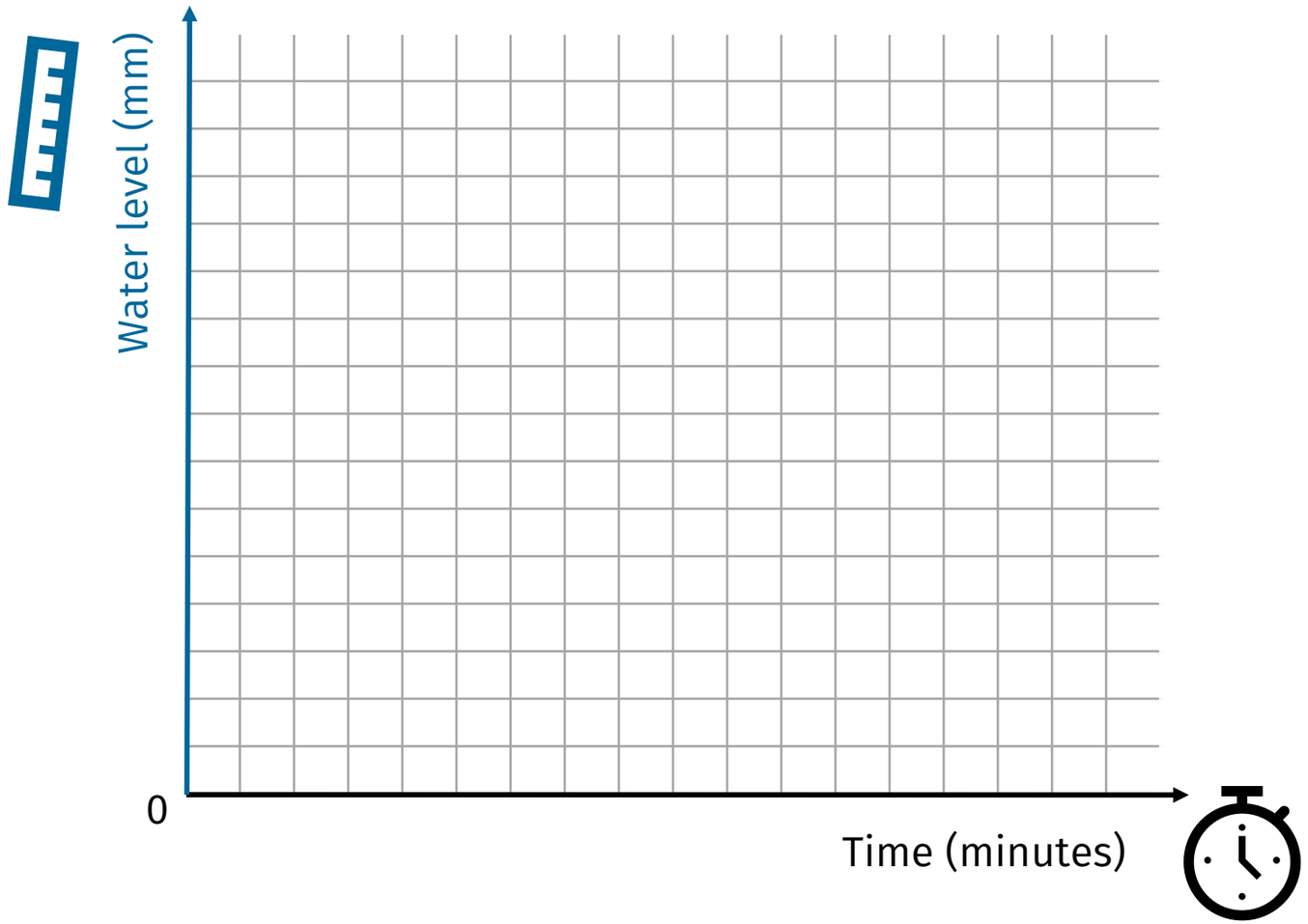
Note

1. For consistency, measure the water level at the same place each time.
2. The guidance times and water amounts above are an example, you can use your own if you like!

Polar ice experiment analysis

Can you create a graph of your results?

Graph to show the increase in water level as the ice melted.



Questions and learning outcomes

1. What happened to the ice in the water and on land? _____
2. What happened to the level of water over time? _____
3. What causes the icebergs to melt in the water? (Use page 36 and 43 to help you).

   _____
4. What causes the ice on land to melt? (Use page 36 and 43 to help you).

   _____
5. Which ice took longer to melt – ice on land or ice on water?

   _____
6. Why do you think this is?

   _____
7. When the ice turns from a solid to a liquid, this temperature is called what? (Use page 46 to help you)

   _____
8. What was the outcome for the polar animals?

   _____
9. Why is it important to try and slow the amount of ice melting in Greenland and Antarctica?

   _____

   _____
10. What does your graph show?

    _____

PLAY ● LEARN ● CHANGE THE WORLD

What we do in the next 10 years will determine the next 1000.

When we all pull together, achieving the almost impossible is what humans do best.

David Attenborough

What can we do?

- We must take action to reduce the amount of GHG's we release into the atmosphere both individually and as a nation to reduce global heating.
- There will more in the Atmosphere Funbook (coming soon) about how you can reduce your GHG emissions, but because the cryosphere is of national and international importance, we want YOU to take action for our cryosphere by making the issues known to our government.
- Write letters to our MP's about
  - preserving the Cryosphere
  - stopping subsidising fossil fuels
  - reducing the UK's ecological footprint
  - and working towards net zero carbon dioxide by 2050

Tell your MP that the cryosphere matters!

Being a steward or activist for our planet by writing to your local MP on the importance of the Cryosphere is a great place to start helping our world! The more people who write to those in charge of our country, the more likely our leaders will do something about it.
A roundup of the Funbook and important facts and suggestions we need to tell our MPs:

- The cryosphere MATTERS! It's more important than we think. It's the Earth's thermostat and regulates its temperature.
- We need to protect the ice sheets in Greenland and Antarctica that are melting more rapidly than ever as a result of climate disruption (increased greenhouse gases trapped in the Earth's atmosphere). This is causing global heating. The Greenland Ice Sheet alone holds enough water to raise the sea level by 7.4 meters.
- If we don't protect these polar regions, sea levels will rise by 71cm by 2100 (NASA and IPCC data 2020).
- Coastal cities will flood causing 400 million people's lives to be displaced.
- Polar animals are already losing their habitats and food, which is threatening their existence.
- The current UK government target is net zero greenhouse gases by 2050. The UK government must accelerate the transition to clean energy and work harder to be on track with the 6th carbon budget, which the CCC will be advising in September 2020.
- The government must plant more trees which will lock carbon back up in the trees and the soil. We must rewild our planet by allowing other habitats such as wildflower meadows, seagrass beds, mangroves and marsh lands to recover. They're essential in reducing carbon in the atmosphere and stabilising the climate.
- Stop supporting the companies who are burning our planet's valuable finite fossil fuels, instead provide subsidies to invest and promote renewable energies.
- Use more green technology like carbon capture and storage to prevent increasing levels of CO2 in the Earth's atmosphere.
- PROTECT the Arctic. Stop exploring and exploiting. We need to keep offshore oil in the ground for good to protect the global climate and the indigenous people and animals that call the Arctic home.

> **We will succeed - and that success will belong to every one of us.**
>
> *Queen Elizabeth II*
> *2020*

This positivity is how every one of us, including the government, must approach the climate crisis and sustainability.

We need to rise up, change our behaviours, do better and succeed in balance with nature!

Tell your MP that the cryosphere matters!

- You can find out the contact and name of your local MP by visiting **members.parliament.uk** and typing where you live into the search bar.
- Print the next page and complete your name, age, and address clearly at the bottom of the letter so your MP can write back to you!
- Add your own message to your MP explaining why you want them to help protect the cryosphere. There are plenty of suggestions on the previous page.
- Write the address below on an envelope – and don't forget to add a stamp!
- We would love to see what you write!
- Please email us a photo of the letter at contact@maintenant.org.uk

My MP name

House of Commons
London SW1A 0AA

MAINTENANT
Sustaining Now
maintenant.org.uk

To my MP _____

House of Commons
London
SW1A 0AA

THE CRYOSPHERE MATTERS !

Dear my MP _____

I want the United Kingdom government to protect the Earth's Cryosphere (ice on land and in water) and take appropriate measures to stop the Earth's Global Climate System breakdown.

_____

_____

_____

_____

_____

_____

Yours Sincerely,

My name _____

My address _____

My age _____

My signature _____

To find out more about the Cryosphere, download maintenant.org.uk/cryosphere-funbook

By completing this Funbook you have also helped the cryosphere.
By learning about the cryosphere you are now one of its ambassadors.

PLAY ● LEARN ● CHANGE THE WORLD

Positivity and Hope!

In September 2019 the IPCC (Intergovernmental Panel on Climate Change) released a Special Report on the Ocean and Cryosphere in a Changing Climate.
It highlighted the importance of sustainability in **EDUCATION**. Reading our Funbook means you are learning what needs to be done to look after our planet!

Please tell your family and friends what you learn!

Many non-government organisations are taking huge positive action! WWF (World Wildlife Fund) are planting seagrass beds in the UK to increase the amount of carbon absorbed in the sea. They have also helped double the amount of Arctic that has protected status from 5.6% to 11%!

We can all live more sustainably and help bring about positive change to ensure a good future for us and generations to come!

DIVERSITY DECK® Funbook

CRYOSPHERE GLOSSARY

PLAY ● LEARN ● CHANGE THE WORLD

1	**Adaptation**	A feature of a living thing which helps it to survive
2	**Albedo**	The measure of reflection of solar radiation from a planet or moon's surface
3	**Algae**	A single or multi-cellular organism that is often found in water. It is not a plant although it uses photosynthesis to produce its own food
4	**Atmosphere**	The gases which surround out planet
5	**Biosphere**	The areas of the Earth which contains all the living organisms on Earth
5	**Climate**	The usual weather conditions in an area in general or over a long period
6	**Cryosphere**	All the ice on Earth
7	**Deforestation**	When a forest is cut down, burnt and destroyed by human activity
8	**Glacier**	A thick sheet of ice which remains frozen from one year to the next. It moves very slowly over the Earth's surface
9	**Ecosystem**	A community of organisms and their environment interacting together
10	**Environment**	The conditions of a habitat including light, temperature and other organisms
11	**Energy**	The ability "to do work" and create change
12	**Fauna**	The animals of a particular region of geographic location
13	**Flora**	The plants of a particular region or geographic location
15	**Fungi**	A group of living organisms which are classified in their own kingdom. This means they are not animals, plants, or bacteria. They have complex cells like plants and animals
16	**Hydrosphere**	All the water on the planet
17	**Ice shelves**	A floating area of ice which is attached to a land mass. It is normally formed by ice slowing flowing from a glacier.
18	**Indigenous**	Originating naturally from a particular place
19	**Lithosphere**	The Earth’s crust and everything in it
20	**Permafrost**	An underground layer of soil, gravel and sand which is frozen for more than 2 years at a time.
21	**Sustain**	Continue for a period of time without being stopped or interrupted
22	**Tundra**	A biome which prevents trees from growing as it is too cold and there is not enough of the sun's energy

Cryosphere wordsearch

- Complete this wordsearch to familiarise yourself with some words about the cryosphere. There is a glossary at the end of this book for you to use if you are not sure of their meaning. Some words are also linked to pages on our Educational Hub.

E	M	I	C	E	S	H	E	E	T	S	R	V	A	J
R	I	C	E	B	E	R	G	S	U	E	P	S	Z	X
E	G	S	D	K	J	A	L	B	E	D	O	Q	U	A
H	W	A	R	C	Y	N	I	E	R	O	C	E	C	I
P	U	R	S	A	H	T	G	P	O	L	A	R	S	R
S	N	O	W	F	L	A	K	E	F	O	I	T	E	G
O	B	R	F	R	I	R	Y	N	A	R	W	H	A	L
Y	T	U	O	O	S	C	A	G	T	C	H	U	L	A
R	L	A	K	Z	O	T	P	U	I	A	D	S	Z	C
C	A	W	H	E	R	I	C	I	G	T	X	K	O	I
E	F	I	J	N	H	C	U	N	L	N	R	Y	O	E
U	Q	P	E	R	M	A	F	R	O	S	T	E	L	R
G	R	E	E	N	L	A	N	D	O	P	M	C	A	S

For the experts

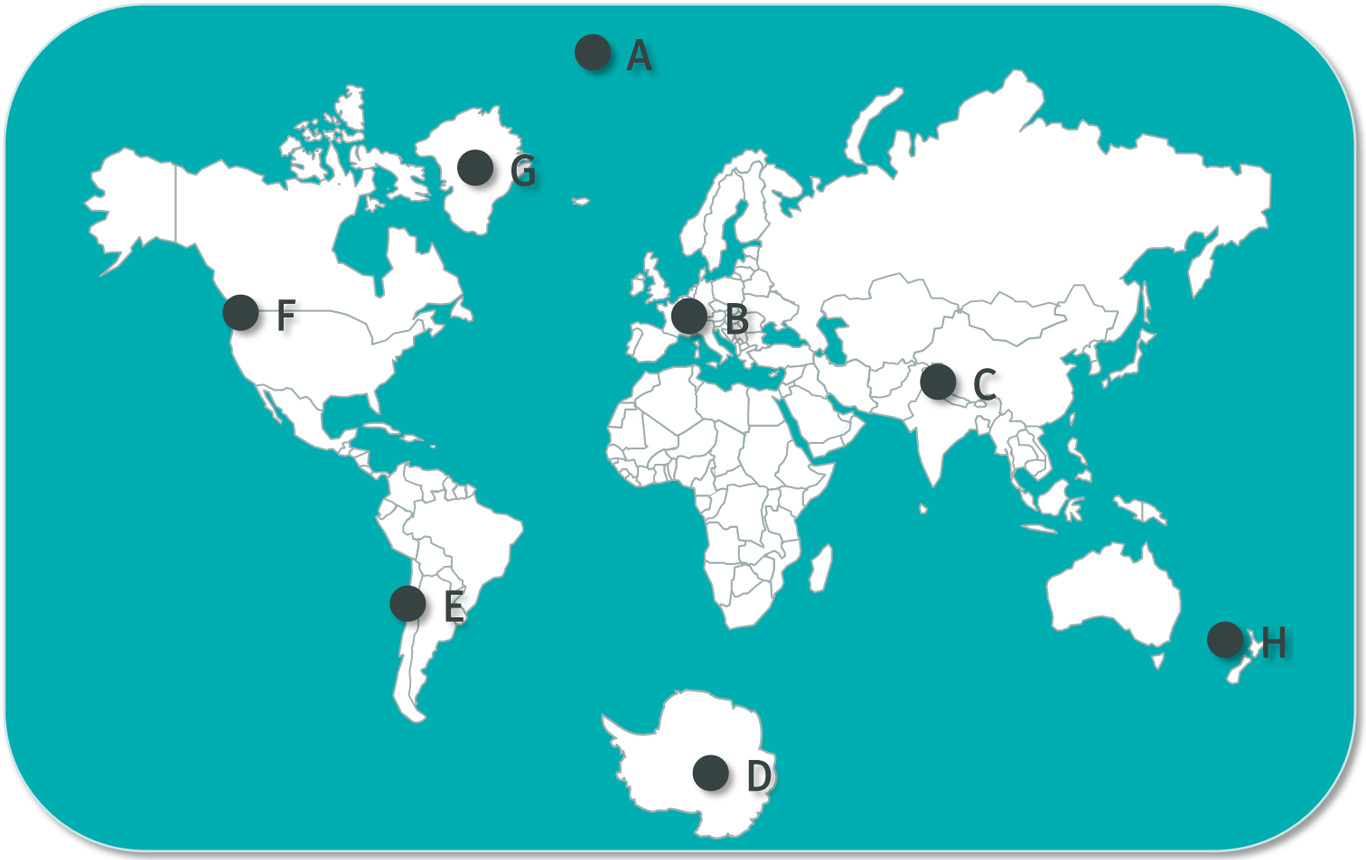
- Where is the largest ice-sheet in the North Pole?
- Can you find it?

GREENLAND

- [ ] Albedo
- [ ] Antarctica
- [ ] Auroras
- [ ] Cryosphere
- [ ] Frozen
- [ ] Glaciers
- [ ] Husky
- [ ] Icebergs
- [ ] Ice-core
- [ ] Ice-sheets
- [ ] Igloo
- [ ] Narwhal
- [ ] Orca
- [ ] Penguin
- [ ] Permafrost
- [ ] Polar
- [ ] Seal
- [ ] Snowflake

Where in the world is the cryosphere?

- The cryosphere is mainly found in the polar regions, but glaciers and ice-capped mountains can be found in most mountain ranges across the world.
- Can you label the map where the main areas of the cryosphere are found?

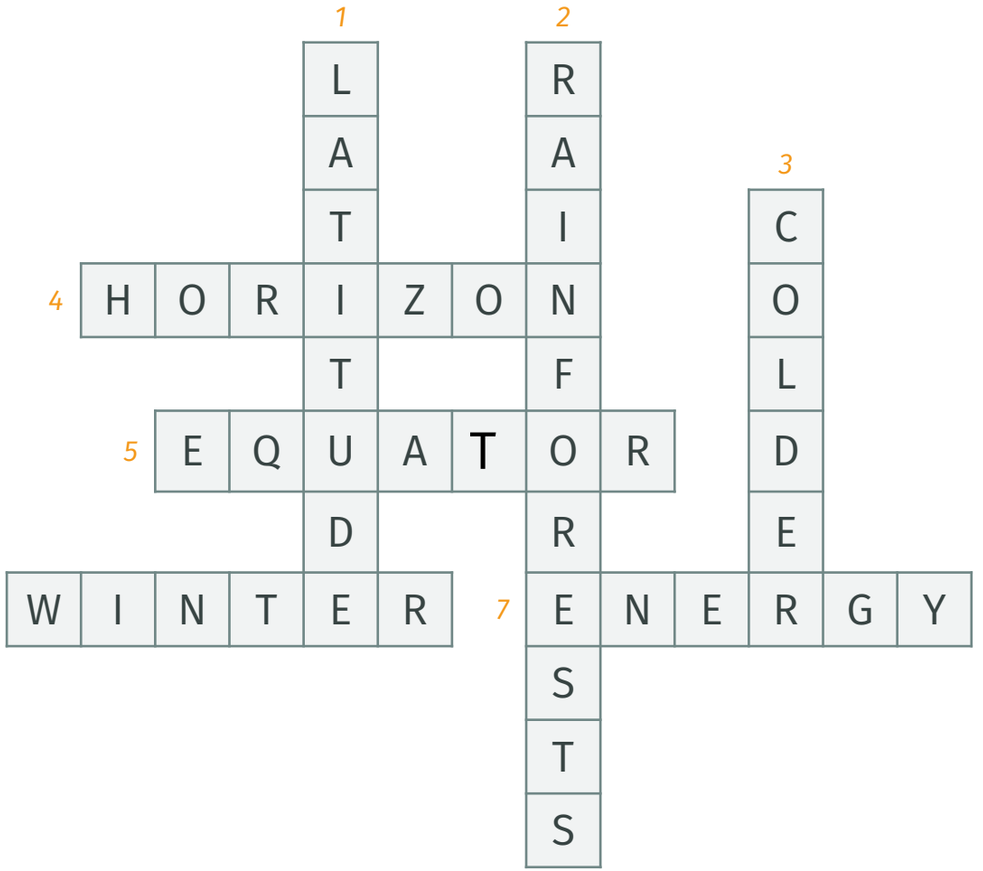


D	Antarctica
A	Arctic
G	Greenland
H	New Zealand Southern Alps
B	The Alps
C	The Himalayas
F	The Rocky Mountains
E	The Andes Mountains

Sun’s energy crossword

- Down
  1. The name given to the imaginary lines around the Earth which describe how far north or south you are.
  2. Levels of sunlight and rain near the equator are so great that it provides the perfect conditions for _ _ _ _ _ _ _ _ _ _ _ to grow.
  3. Near the Poles, the sun's energy is spread out making temperatures _ _ _ _ _ _.

- Across
  4. In the poles, the sun is always low on the _ _ _ _ _ _ _ _.
  5. Energy from the sun strikes the Earth almost directly at the _ _ _ _ _ _ _ .
  6. The season where the sun disappears for months on end in the poles.
  7. Different parts of the Earth receive different amounts of the Sun’s _ _ _ _ _ _ .



Decipher this claim

- Many native Arctic populations in Russia use the Cyrillic alphabet to transcript their languages and dialects.
- Can you work out this sentence below.

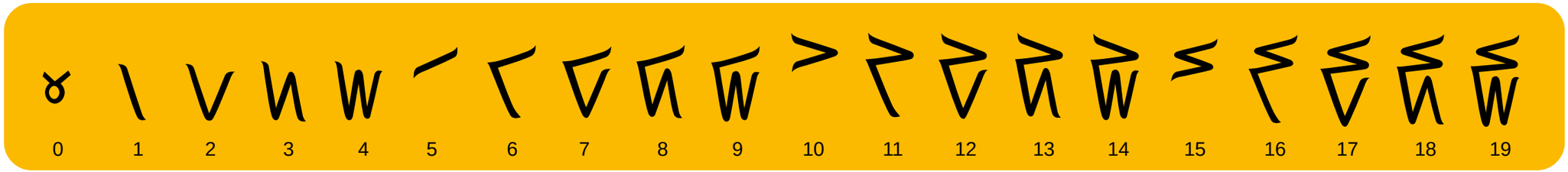
YE APE ПАРТ ОФ THE СОЛУТИОН БЕЦАУСЕ YE APE ЦОННЕЦТЕД ТО ОУР ЕНВИРОНМЕНТ.

We are part of the solution because we are connected to our environment.

- Why do you think they say this?

A	А
B	Б
C	Ц
D	Д
E	Е
F	Ф
H	Н
I	И
L	Л
M	М
N	Н
O	О
P	П
R	Р
S	С
T	Т
U	У
V	В
W	Y

Count like an Iñupiaq



- Can you complete the table?

Decimal	Iñupiaq
20	\ 0
21	\ \
22	\ V
23	\ ᐱ
24	\ W
40	V 0
41	V \

Extension exercise

Decimal	Iñupiaq
40	V 0
47	V ᐁ
50	V >
51	V ᐳ
80	W 0
400	\ 0 0
416	\ 0 ᐸ

The consequences of global heating on sea levels

- Can you fill in the blanks using the words below?

Greenhouse gases are emitted into the atmosphere from burning fossil fuels and permafrost melting.

A blanket of greenhouse gas in the atmosphere traps heat and warms the planet.

Feedback loop

Ice sheets, glaciers and permafrost melt.

Feedback loop

Albedo is reduced so more of the Sun's energy is absorbed by the planet.

Sea temperatures increase.

As water heats up, it expands, further adding to sea levels rising.

Sea levels rise.

- ☐ energy
- ☐ expands
- ☐ Greenhouse gases
- ☐ Ice sheets
- ☐ increase
- ☐ planet
- ☐ Sea levels

As the Earth heats up, ice around the globe is melting with serious consequences.

Once the cryosphere has warmed and melted too much, a **tipping point** will be reached where we cannot save it.

The Earth will continue to heat, the cryosphere will melt and sea levels will rise.

An Antarctic Explorer's Diary 2/2

Questions

1. Is the weather better or worse in the Shackleton Range than The Patriot Hills Camp? Why do you think that?
   The weather is better because it is warmer and there is less wind.

2. Why does the author feel "unheroic" for being in an airplane?
   Because there was a previous team who had to cross over the difficult landscape by foot and he had the easy job of going in the airplane.

3. What three things made the campsite so perfect?
   It's on rock not ice, it's flat and there were stakes left behind from a previous expedition.

4. What will they do to reconstruct the history of the ice sheet they are studying?
   Survey and sample glacial erratics or glacial erratic rocks at different altitudes/heights.

5. Why do you think he made reference to the sun still being up as it was time to go to bed?
   It is January (summer) and the sun doesn't set in Antarctica in the summer.

You can read more of this diary at The School of Geosciences of The University of Edinburgh's website
The following day, there was quite a dramatic accident!

Questions and learning outcomes

1. What happened to the ice in the water and on land? It melted.
2. What happened to the level of water over time? It rose.
3. What causes the icebergs to melt in the water? (Use page 36 and 43 to help you).
   Rising sea temperatures as a result of increased GHG in atmosphere due to fossil fuels being burnt
4. What causes the ice on land to melt? (Use page 36 and 43 to help you).
   Increasing air temperatures (as a result of increased GHG in atmosphere due to fossil fuels being burnt)
5. Which ice took longer to melt – ice on land or ice on water?
   Ice on land melts slower that ice on water
6. Why do you think this is?
   Water is better at transferring heat to the ice than air (because of thermal expansion).
7. When the ice turns from a solid to a liquid, this temperature is called what? (Use page 46 to help you)
   Melting point.
8. What was the outcome for the polar animals?
   Their habitat disappeared as the ice melted.
9. Why is it important to try and slow the amount of ice melting in Greenland and Antarctica?
   Because they help regulate the earth's temperature and help to keep it cool. They also hold 99% of earth's freshwater so if all the ice sheets melted the sea levels would rise and cause many problems. They also provide an important ecosystem and habitat for plants and wildlife.
10. What does your graph show?
    More ice melted quickly at the beginning of the experiment then it slowed down as time went on.

PLAY ● LEARN ● CHANGE THE WORLD

SUSTAINABLE DEVELOPMENT GOALS

International coalition to leave no one behind

The United Nations Sustainable Development Goals or SDGs are a worldwide plan for all to tackle poverty and environment challenges like climate breakdown.

BUY SOCIAL · BUY SOCIAL ·

ESDGC embedded in schools' curriculum

Education for Sustainable Development and Global Citizenship

Remote virtual online CPD

Please contact us at contact@maintenant.org.uk if you are interested by a teacher CPD on Sustainability Science in general – or how to use this Funbook in particular.

PLAY ● LEARN ● CHANGE THE WORLD

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Sustainability Collection

PLAY ● LEARN ● CHANGE THE WORLD

Earth System Science Education™ our innovative educational methodology

The Earth is a dynamic planet in constant evolution. The Earth System Science represents our planet as a set of strongly interconnected spheres.
MAINTENANT Sustaining Now adapted this global and multidisciplinary approach to tell children about Sustainability Science such as Earth's climate, renewable energy, biodiversity conservation and well being.

EARTH SYSTEM SCIENCE EDUCATION™

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MAINTENANT Sustaining Now is an award-winning social enterprise producing educational sustainability science resources, and running corporate and school workshops which empower children, adults and the whole community to adapt their lifestyles now.

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games@maintenant.org.uk
@Maintenant.Sustaining.Now
@Maintenant_Now
@Maintenant.Sustaining.Now