
NANYANG
GIRLS' HIGH

Take Care of Tomorrow: The Climate Conundrum

Nanyang Girls' High School

Earth and Science Fortnight

Take Care of Tomorrow

Online Presentation

- http://www.nygh.sg/interdisciplinary/ozone_uv_radiation.pdf

Take Care of Tomorrow

Conceptual Lens

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Conceptual Lens

Change generates more *change*. Some *changes* are reversible. *Changes* occur amidst continuities. *Change* can be steady, cyclic, random or chaotic. *Change* is inevitable in all systems. *Change* does not always equal progress, *i.e.* it can be positive or negative. *Change* is linked to time. *Change* can be a consequence of spontaneous and / or planned events. Some *changes* can be measured, analysed and predicted, while other *changes* cannot.

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Generalisations or Enduring Understandings

- Scientific research informs human knowledge and facilitates decision making.
- The Earth's climate is fragile and susceptible to change.
- If left unchecked, changes to the Earth's climate may be harmful and irreversible.
- Human apathy and procrastination towards climate change risks potential disaster.
- Damage to the Earth's atmosphere / climate can be reversed if urgent action is taken.

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Guiding Questions

- What is Climate Change?
- What causes Climate Change?
- What is the Evidence for Climate Change?
- What are the consequences of Climate Change?
- Why do humans procrastinate over Climate Change?
- Is Climate Change necessarily bad for life on Earth?
- What can be done to minimise Climate Change?
- What other challenges does life on Earth face?
- Does humanity change climate, or does climate change humanity?
- Is Climate Change inevitable?
- Is Climate Change reversible?

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- Slowing, stopping and reversing climate change is not only about *saving cute polar bears*.

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- Stopping climate change is also about ensuring that you and your family have *food to eat and water to drink*.


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Take Care of Tomorrow

- Stopping climate change is also about ensuring that you and your family have *somewhere safe to live*.

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- **Video:** National Geographic – Climate 101: Cause & Effects (~4 mins).
  - Click on the video to watch it on YouTube.

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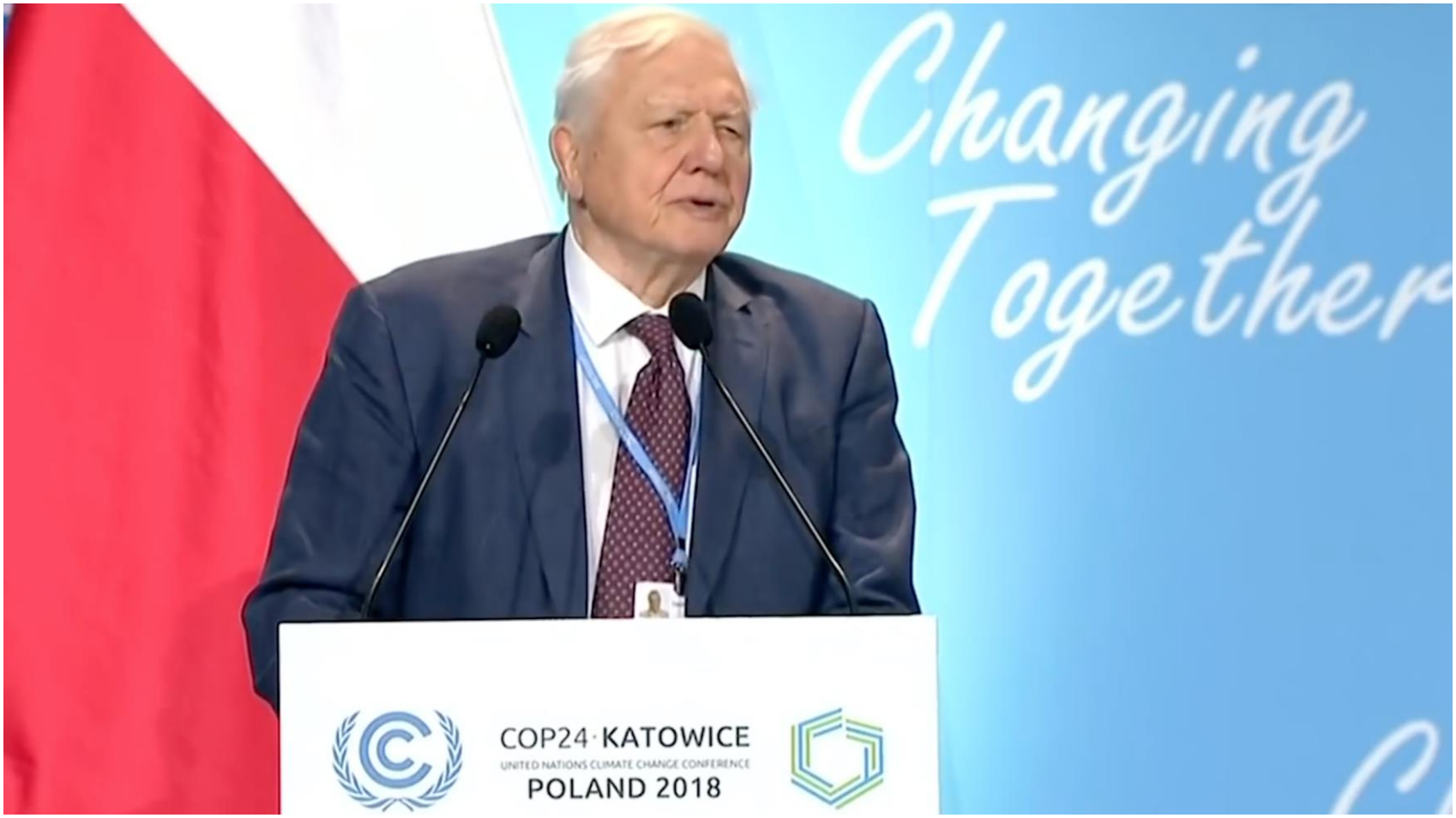

- **Video:** Sir David Attenborough's Speech to the United Nations (~1¼ mins).
  - Click on the video to watch it on YouTube.

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"Unfortunately, the clock is ticking, the hours are going by. The past increases, the future recedes. Possibilities decreasing, regrets mounting."

Haruki Murakami

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"*Change* will not come if we wait for some other person, or if we wait for some other time. We are the ones we've been waiting for. We are the *change* that we seek."

Barack Obama

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- What world would you like to live in?
- What future would you like to have?
- It depends upon the choices that *you* make *today*.


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- **Video:** National Geographic – Leonardo DiCaprio's Speech to the United Nations (~4 mins).
- Click on the video to watch it on YouTube.

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• **Video:** Greta Thunberg's Speech to the United Nations (~3½ mins). Greta Thunberg is a 16 year old Swedish climate activist who has been shortlisted for the Nobel Peace Prize. She rose to prominence after organising the first *school strike for climate*.

• Click on the video to watch it on YouTube.

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We Need to Change the Way We Live

Why is this so Difficult to Do?

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We Need to Change the Way We Live

Why is this so Difficult to Do?

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We Need to Change the Way We Live

Why is this so Difficult to Do?

- The catastrophic changes are in the more *distant future*, *2050* and *2100*, so they may not affect me.
- The catastrophic changes are not taking place in my country, but are taking place in *distant locations* around the world.
- Consequence: These changes do not directly impact me, so *they do not concern me*.

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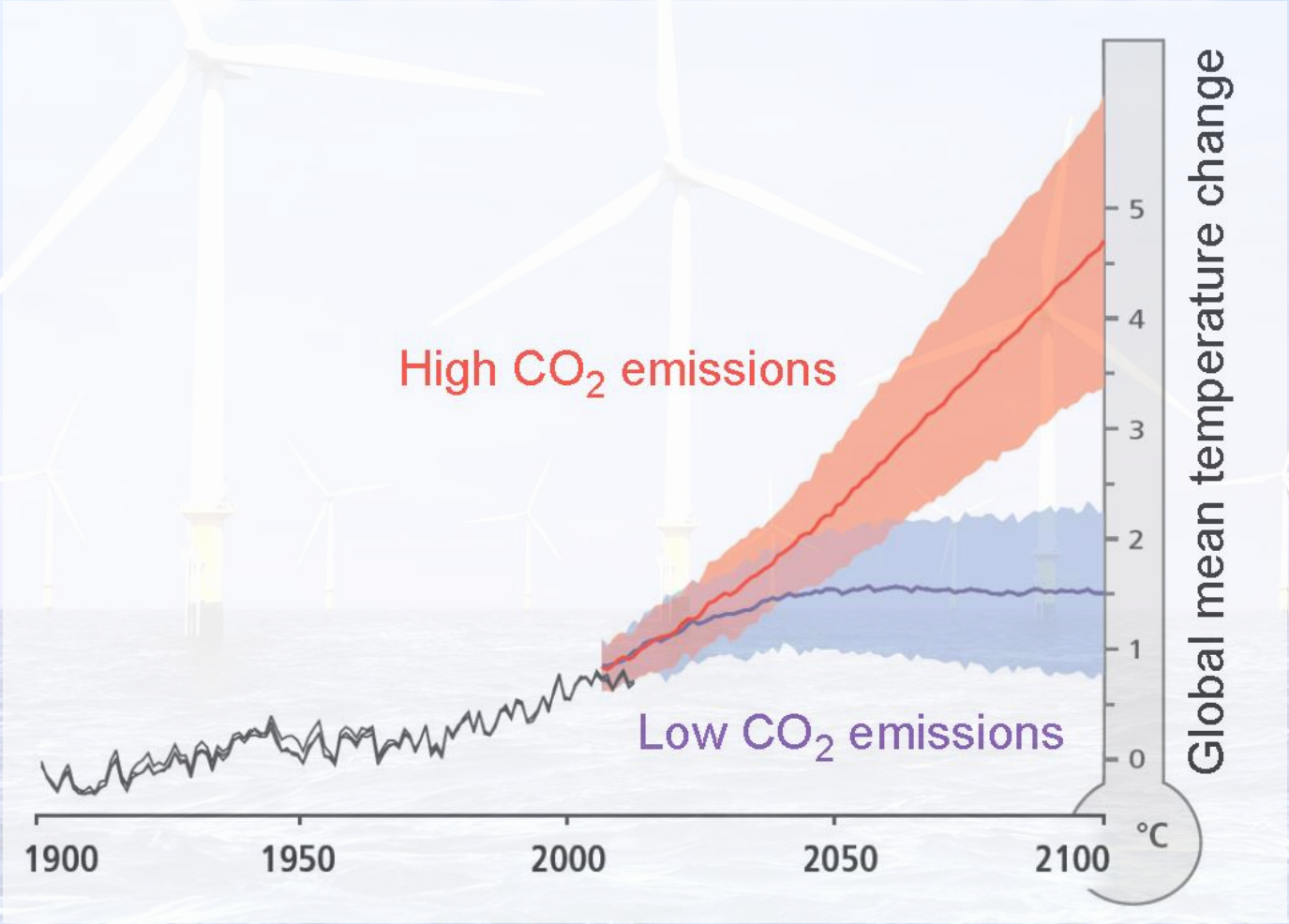
Why is this so Difficult to Do?



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We Need to Change the Way We Live

Why is this so Difficult to Do?

- What can humanity do, and what can we do as individuals, in order to – slow down – stop – reverse – climate change?

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We Need to Change the Way We Live

Why is this so Difficult to Do?

- Generate electricity from solar energy.
- Generate electricity from geothermal energy.
- Generate electricity from wind energy.
- Generate electricity from hydroelectric energy.
- Use hybrid or electric vehicles.
- Walk, bicycle, take public transport.
- Reduce food wastage and save water.
- Reduce, reuse, recycle plastics.
- Reduce the use of concrete.

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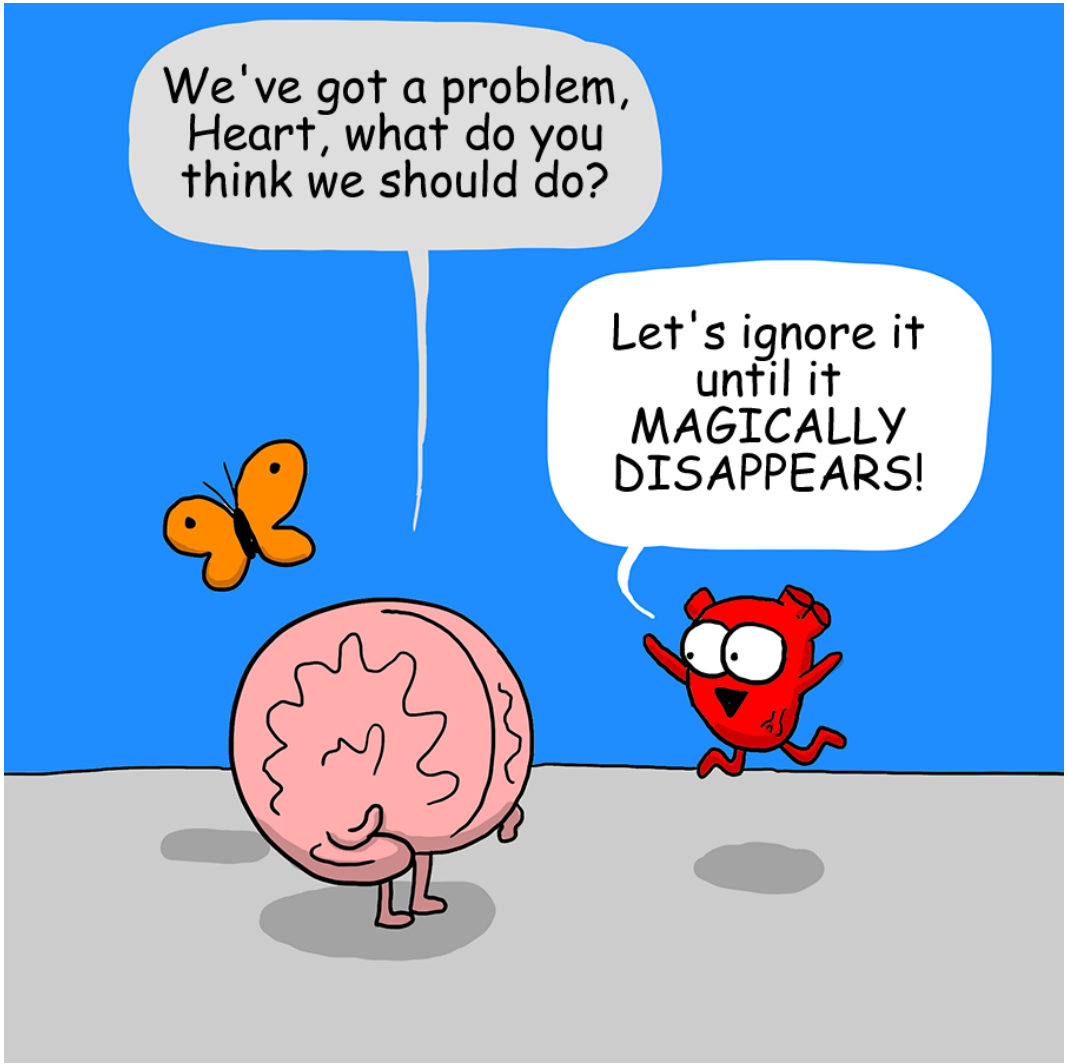

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- It is not all “doom and gloom”.
- The *changes* that we need to make in order to save the Earth’s climate are not impossible.
- Humanity has already made *changes* to overcome one environmental crisis – *the hole in the ozone layer*.

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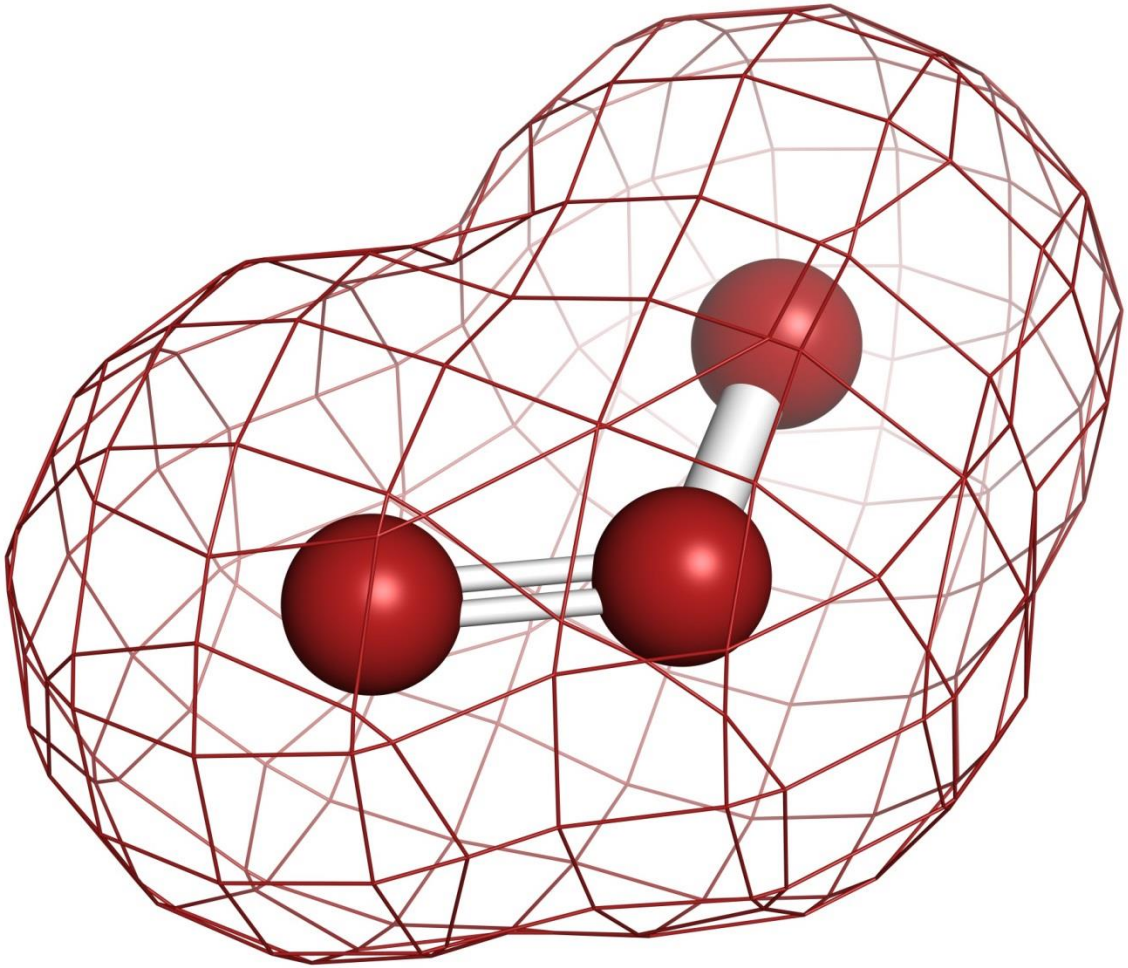
The Ozone Layer



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The Ozone Layer

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The Ozone Layer

- Take 10 to 15 white beads and string them onto a pipe cleaner to make a simple bracelet.

- Warning – The beads are a choking hazard!
- Warning – The ends of the pipe cleaners may be sharp!

- The white beads have a special property. Conduct some simple experiments to find out what it is.


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The Ozone Layer

- The beads can *change colour*.

- What factor(s) cause the beads to *change colour* ?

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The Ozone Layer

- You have been provided with various sunblocks, with different sun protection factors (SPF).
- Apply a small amount of each sunblock to a different bead on your bracelet.
- Now expose the bracelet to sunlight. What conclusions can you draw?

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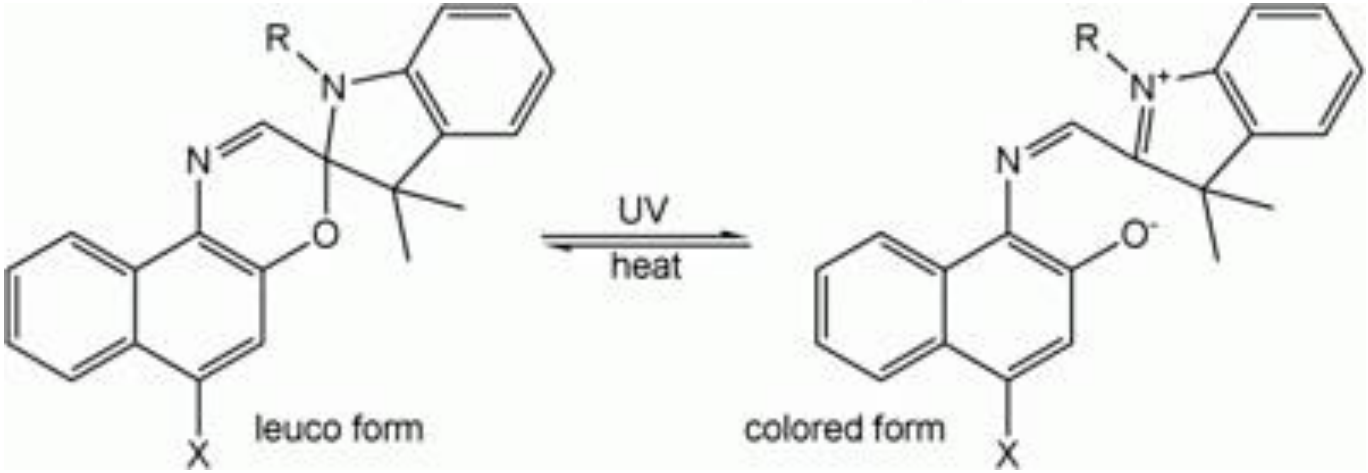
The Ozone Layer



- *Sunblock reflects *ultraviolet radiation*, thus protecting the material underneath from ultraviolet rays.
- The beads contain a photochromic dye – a chemical that changes colour when exposed to *ultraviolet radiation*.
- The beads with the higher SPF applied to them should change colour more slowly.

*Sunblock reflects UV radiation while sunscreen absorbs UV radiation.

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The Ozone Layer

- Take some photographs of your UV detecting bracelet both indoors (the beads are white) and outdoors (the beads are coloured). You can upload the photographs into a shared document later.

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More Experiments to Explore

- Measure the ultraviolet light emitted from the sun on different coloured beads, and at different times of the day – you will find that the ultraviolet sensitive beads change colour much faster at midday than in the late afternoon. As an extension to this investigation, take your beads outside at the same time of day, but under different weather conditions. Does cloud cover change the amount of ultraviolet light that you are exposed to?

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More Experiments to Explore

- Experiment by submerging coloured beads in water of different temperatures (lukewarm, hot and ice cold). How does temperature affect the rate at which the beads (or pigment molecules) revert to being colour-free?

- Test the effectiveness of your sunglasses by placing some beads behind the sunglass lenses and others in full view of the sun. Do the beads shielded by the sunglasses remain white and protected from harmful UV radiation?

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More Experiments to Explore

- Test your sunscreen by rubbing some on the beads and then exposing these beads to sunshine. Do they stay white and protected from Ultraviolet rays or is it time to change brands or throw out old sunscreen that might be out-of-date?

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Chemistry of the Colour Changing Beads

- Ultraviolet (UV) light is one of the invisible frequencies of light that is given off by the sun. Over exposure to it can be harmful to many things including humans. Its effects can be seen in faded paper, a sunburn, and a cracked rubber hose.

- UV sensitive beads contain a pigment that changes colour when exposed to ultraviolet light from the sun or other UV sources. The UV sensitive beads are, however, not affected by visible light and so will remain white indoors or when shielded from ultraviolet light.

- The electromagnetic radiation needed to affect change is between 300 and 360 nm in wavelength. This includes the high-energy part of UV Type A (320 - 400 nm) and the low energy part of UV Type B (280 - 320 nm).

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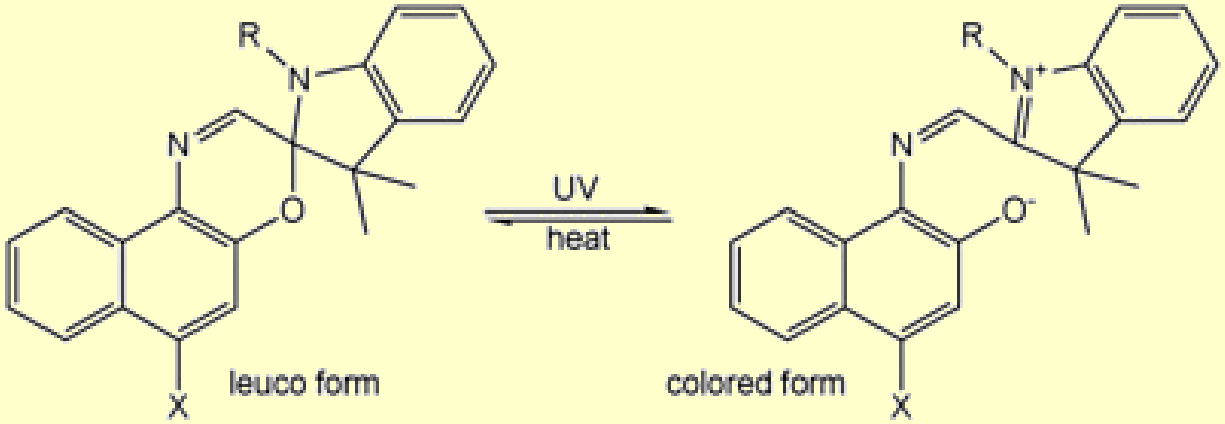
Chemistry of the Colour Changing Beads



- The dye molecules consist of two large, planar, conjugated systems that are orthogonal to each other. No resonance occurs between the two orthogonal parts of the molecule. Imagine two planes at right angles to one another, connected by a carbon atom. When high energy ultraviolet light excites the central carbon atom, the two smaller planar conjugated parts form one large conjugated planar molecule. Initially, neither of the two planar conjugated parts of the molecule is large enough to absorb visible light and the dye remains colourless.

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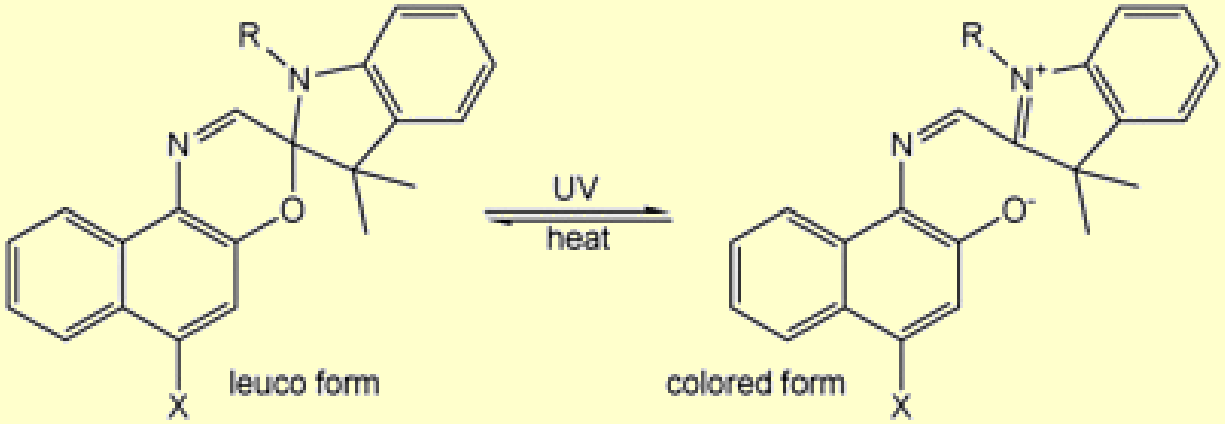
Chemistry of the Colour Changing Beads



- When excited by ultraviolet radiation, the resulting larger planar conjugated molecule absorbs certain wavelengths of visible light, resulting in a colour. The longer the conjugated chain, the longer the wavelength of light absorbed by the molecule. By changing the size of the two conjugated sections of the molecule, different dye colours can be produced.

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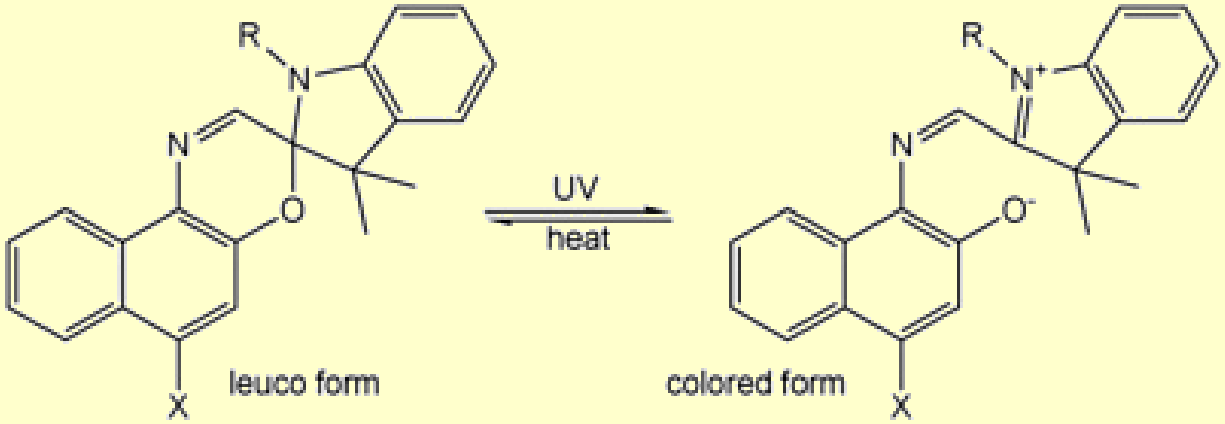
Chemistry of the Colour Changing Beads



- Heat from the surroundings provides the activation energy needed to return the planar form of the molecule back to its lower energy orthogonal colourless structure. If coloured beads are placed in liquid nitrogen at –196 degrees Celsius they will not have enough energy (equal to or greater than the activation energy) to return to the colourless form.

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The Ozone Layer

- So, what is the relationship between the *ozone layer* and *ultraviolet radiation*?

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The Ozone Layer

- Ozone, O_3, is an *allotrope* of oxygen. It is a pale blue gas with a pungent odour.

- Ozone is considered a pollutant at ground level. It is toxic when present in concentrations above 100 ppm (parts per million). However, in the *stratosphere* (a layer of the atmosphere 20-50 km above the Earth's surface) ozone is very important.

- Ozone is formed in the Earth's upper atmosphere by the effect of sunlight on oxygen:

oxygen $\rightarrow$ ozone

$$3O_2(g) \xrightarrow{\text{sunlight}} 2O_3(g)$$

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The Ozone Layer

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The Ozone Layer

- The ozone layer is important because it filters some of the harmful *ultraviolet* (UV) *radiation* from the sun.

- Too much ultraviolet radiation can cause *skin cancer*, genetic mutations and eye damage, *e.g. cataracts*.

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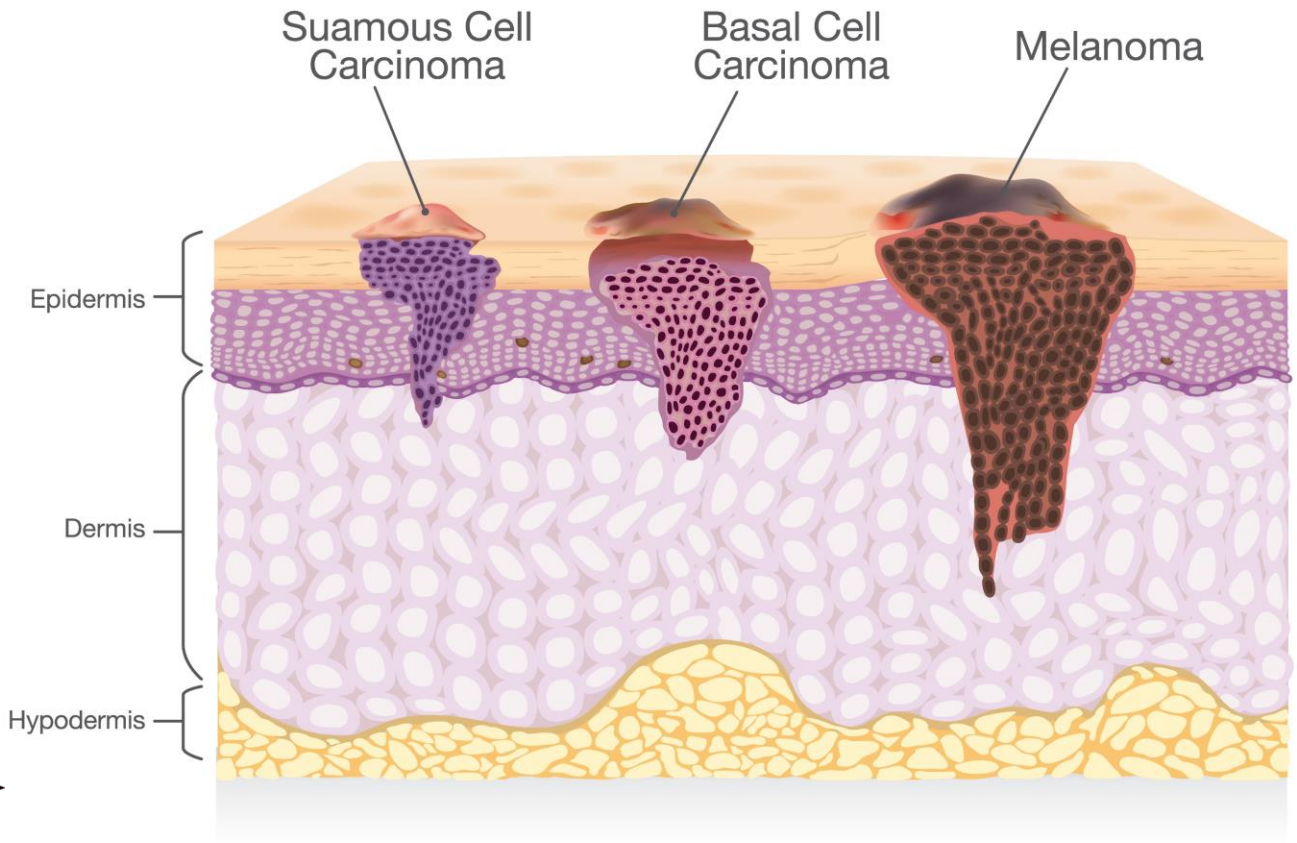
The Ozone Layer

Type of skin cancer



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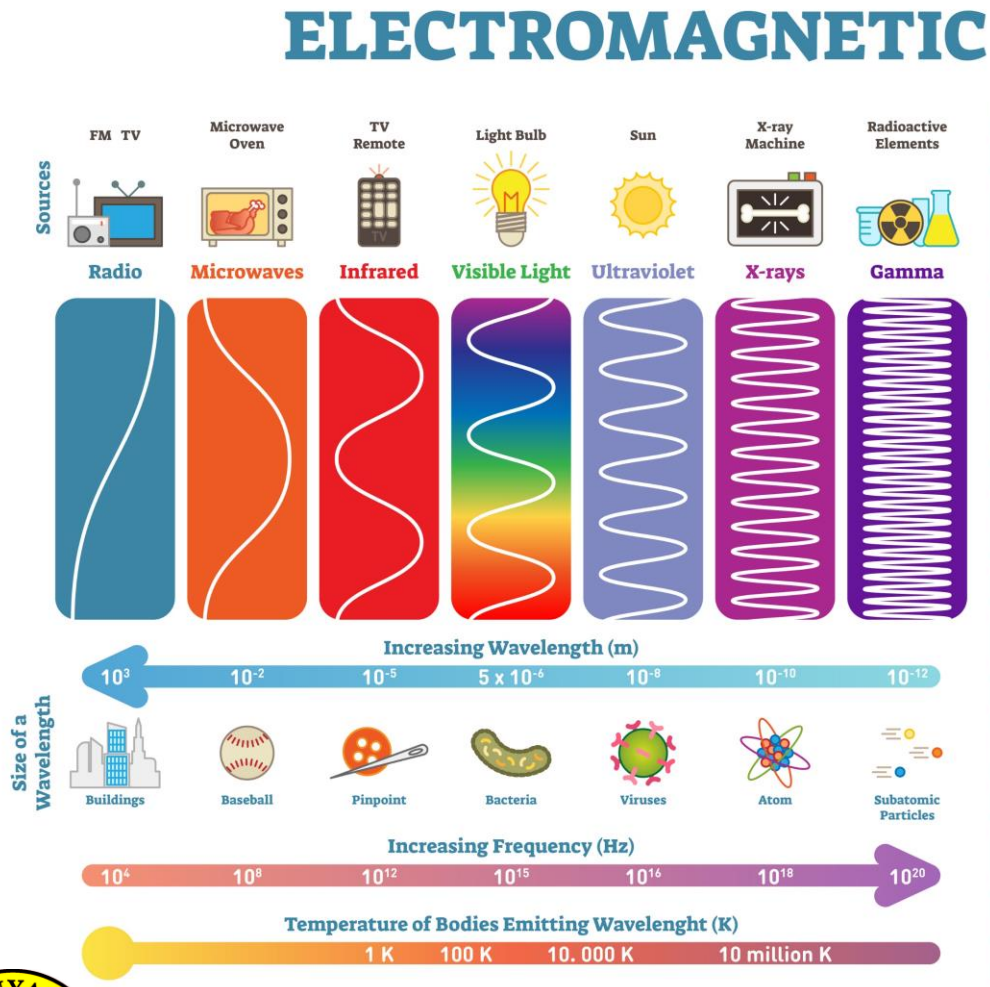

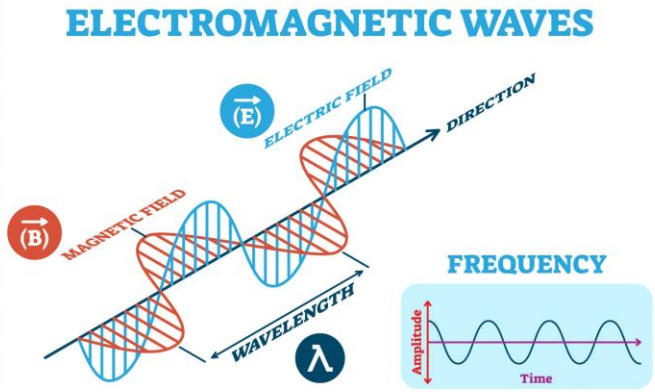

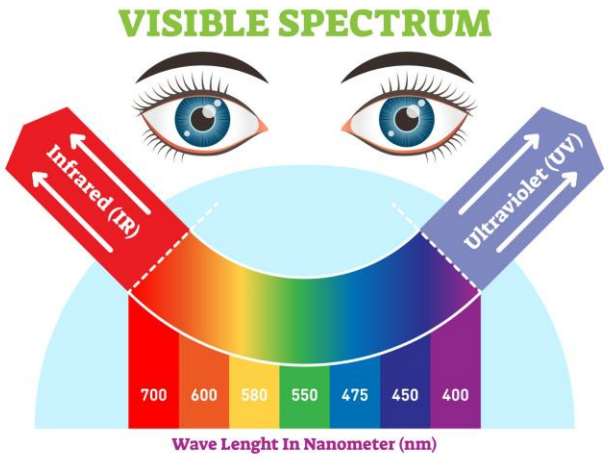

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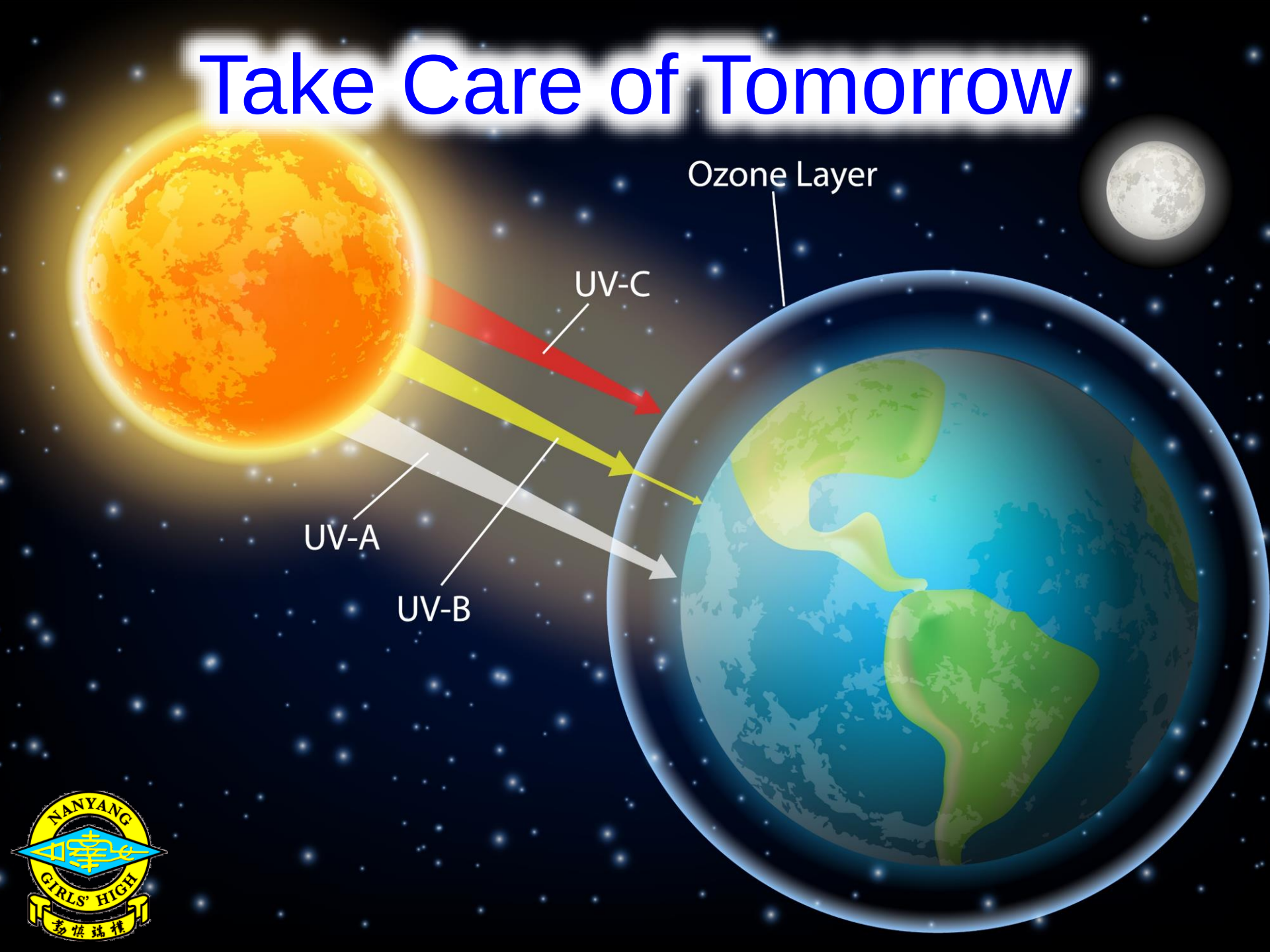

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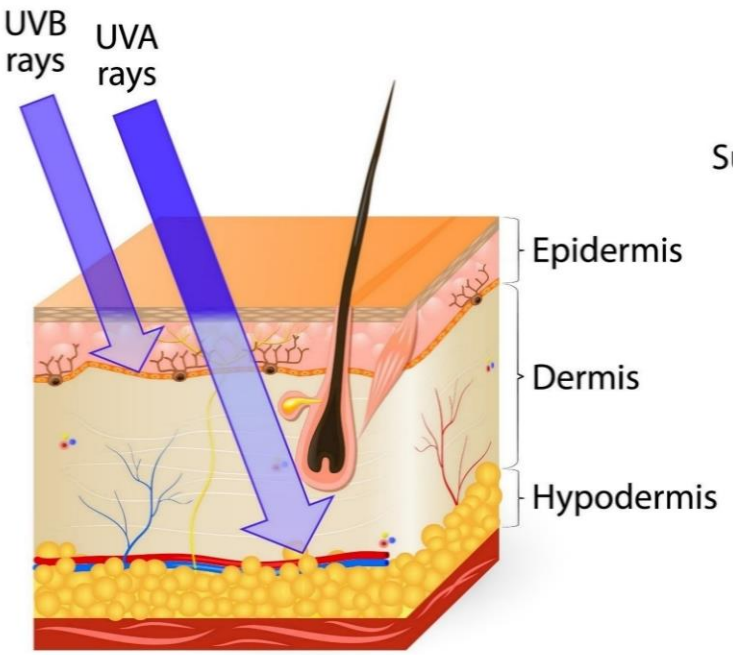
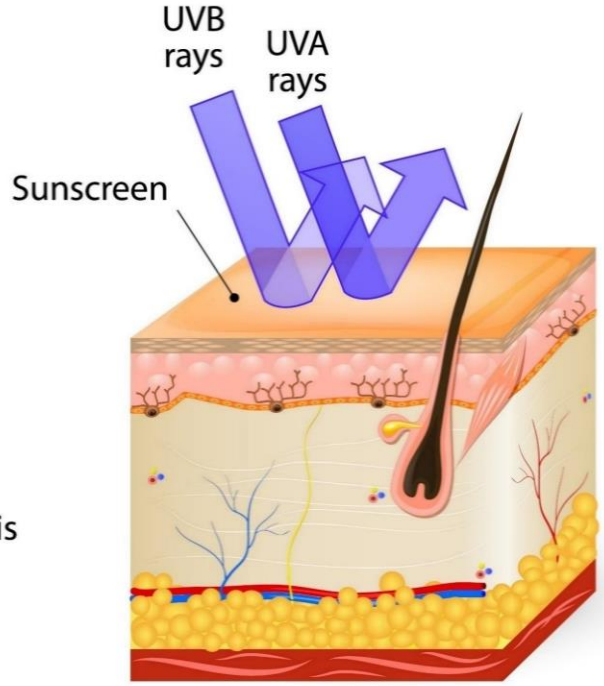
UV penetration into the layers of the skin



Skin without protection



Filter reflect UV radiation

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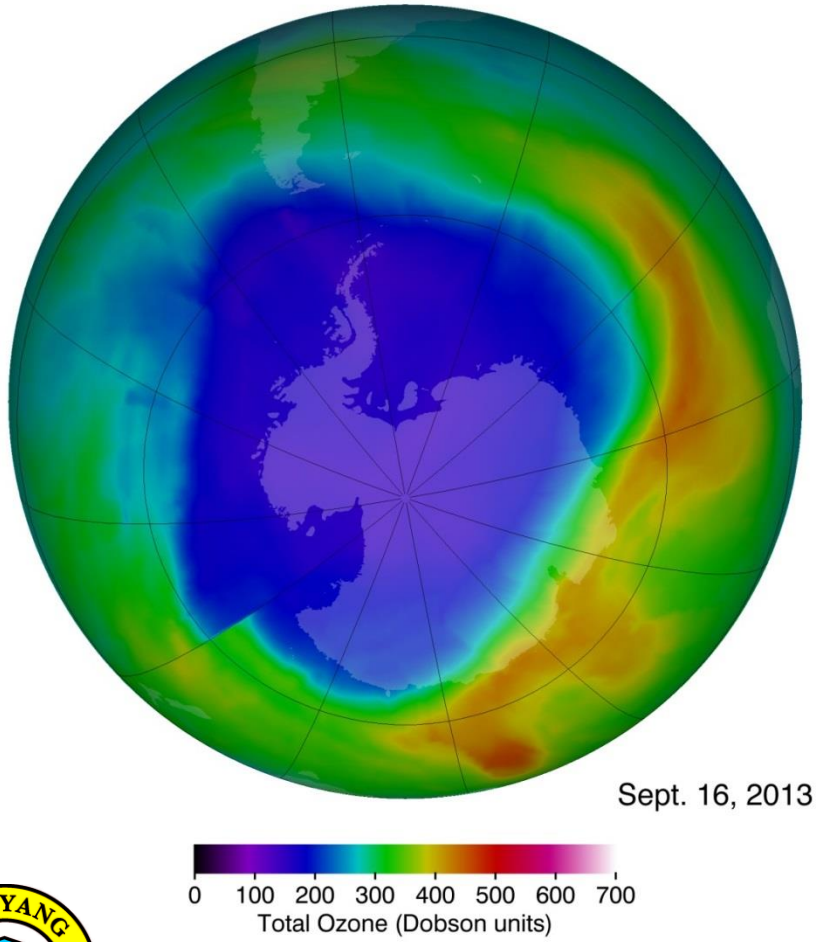

- Since 1976, there has been a *rapid decrease* in the amount of ozone in the stratosphere above the South Pole. Scientists have discovered that one major cause of the ozone depletion are a group of chemicals called *chlorofluorocarbons*.

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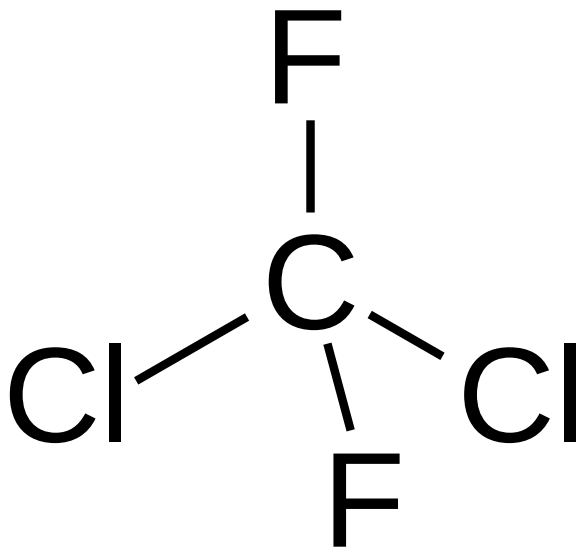
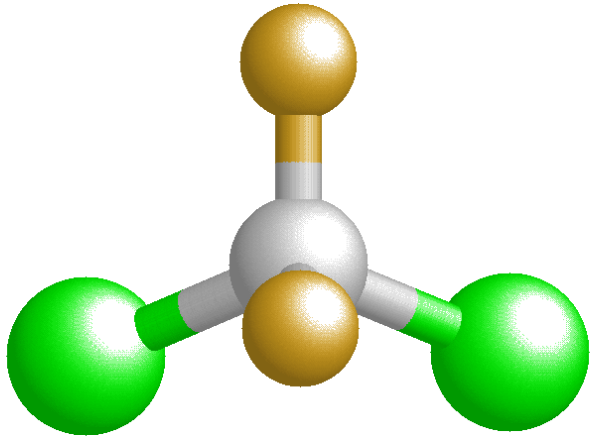
The Ozone Layer





Chlorofluorocarbons

Dichlorodifluoromethane – CCl_2F_2

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The Ozone Layer

- Propellants in aerosols, as well as coolants in refrigerators and air conditioners, release chlorofluorocarbons into the atmosphere.

Chlorofluorocarbons are very stable chemicals and last for many years in the Earth's atmosphere. When they reach the stratosphere, they react with - and destroy - the protective ozone layer.

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The Ozone Layer

chlorofluorocarbon → chlorofluorocarbon radical + chlorine radical

$$CCl_2F_2(g) \xrightarrow{\text{ultraviolet radiation}} CClF_2\cdot(g) + Cl\cdot(g)$$

chlorine radical + ozone → oxygen + chlorine monoxide radical

$$Cl\cdot(g) + O_3(g) \rightarrow O_2(g) + ClO\cdot(g)$$

chlorine monoxide radical + oxygen radical → oxygen + chlorine radical

$$ClO\cdot(g) + \cdot O\cdot(g) \rightarrow O_2(g) + Cl\cdot(g)$$

One chlorofluorocarbon molecule can destroy many ozone molecules.


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The Ozone Layer

- Over the past few decades, there has been a significant increase in the incidence of skin cancer in countries such as Australia as people are exposed to higher levels of ultraviolet radiation. Volunteers can be seen quite regularly on the beaches handing out T-shirts, sunblock and leaflets that warn about the dangers of sunbathing.

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The Ozone Layer

- Many countries have now agreed to ban the use of chlorofluorocarbons. However, even if the use of chlorofluorocarbons were to completely stop immediately, depletion of the ozone layer would continue for many years to come due to the chlorofluorocarbons that are already present in the Earth's atmosphere.

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The Ozone Layer

- **News Update:** Due to the success with which the use of chlorofluorocarbons has been limited worldwide, Scientists now expect the hole in the ozone layer to be *repaired by 2050*.

- Concerted worldwide action to ban the use of chlorofluorocarbons, leading to repair of the ozone layer, shows that humanity *does* have the power to avoid a climate disaster.

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- **Video:** University of California – Climate Lab (~9¾ mins).
  - Click on the video to watch it on YouTube.

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Statement of Understanding

- Write a statement that reflects your understanding of the things that have been discussed in today's lesson. Try to use the conceptual lens of *change* as your write out your thoughts.

- To remind you of what you did today, you may also upload photographs of your UV detecting bracelet showing how the colour *changes*.

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- **S3-01:** Scan the QR code and upload your work into the shared document.

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- **S3-02:** Scan the QR code and upload your work into the shared document.

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- **S3-03:** Scan the QR code and upload your work into the shared document.

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- **S3-04:** Scan the QR code and upload your work into the shared document.

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More to Explore

- The Young Minds Solving Climate Change
- Climate Change: The Massive CO_2 Emitter You May not Know About
- Caution Urged Over use of “Carbon Unicorns” to Limit Warming
- Seven Charts that Explain the Plastic Pollution Problem
- How Streaming Music could be Harming the Planet
- Pollution Linked to One in Six Deaths
- How 1970s Deodorant is Still doing Harm
- How to Solve the Plastic Packaging Paradox

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Presentation on:

Take Care of Tomorrow:
The Climate Conundrum

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