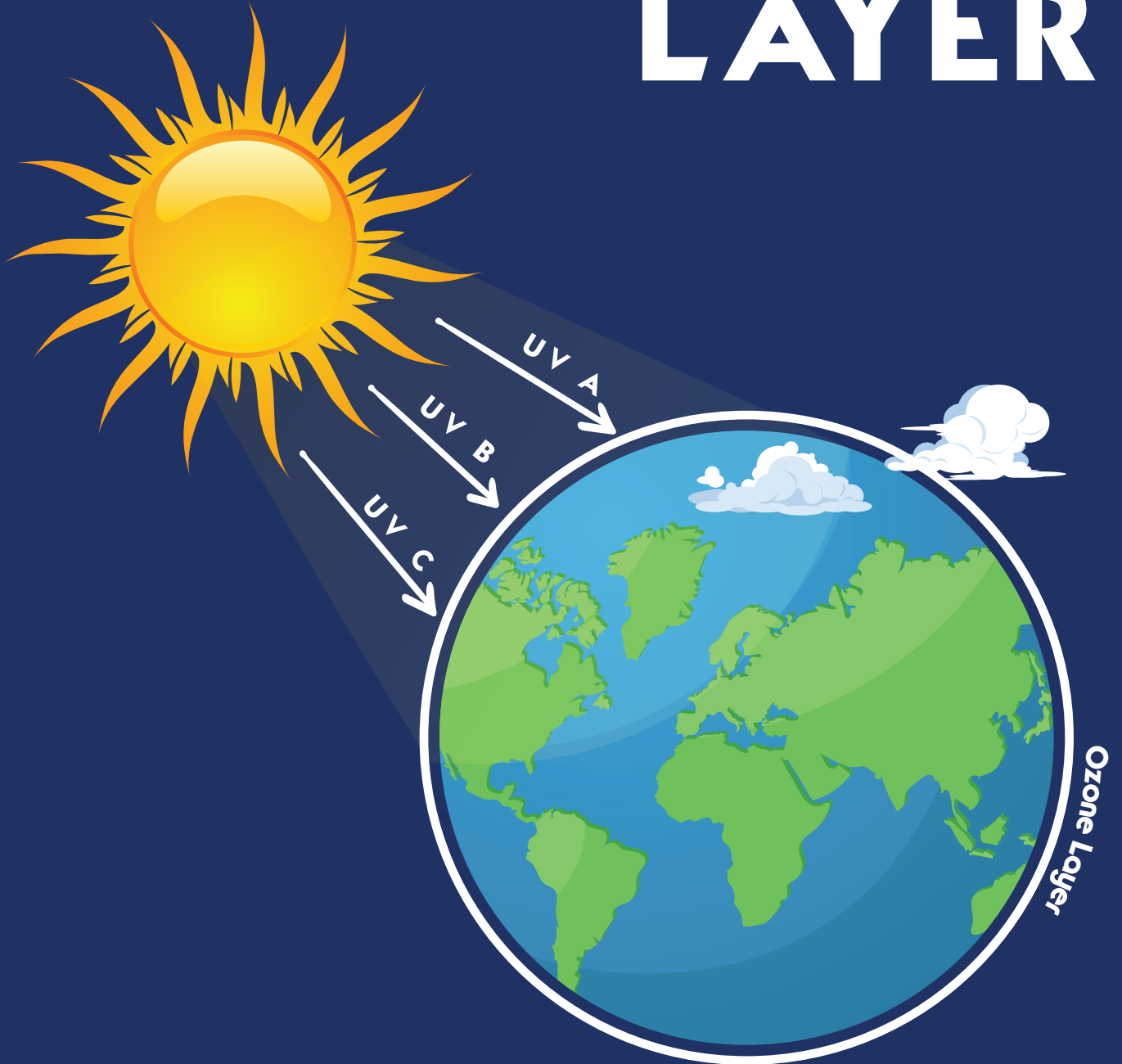




جابتن عالم سكرت تامن دان ريكرياسي

DEPARTMENT OF ENVIRONMENT, PARKS AND RECREATION (JASTRe)  
MINISTRY OF DEVELOPMENT, BRUNEI DARUSSALAM

# OUR ATMOSPHERE'S ABODE OF PEACE: THE OZONE LAYER



# FOREWORD

As a Party to the Vienna Convention and Montreal Protocol since the year 1990 and 1993 respectively, Brunei Darussalam recognizes the importance of a healthy ozone layer and climate to protect the well-beings of both nature and humanity alike. Thus, several efforts including trainings to technicians as well as customs officers and awareness materials have been undertaken to meet the objectives of these global environmental treaties.

The Department of Environment, Parks and Recreation has developed this booklet to educate the public on the importance of the ozone layer. We hope that this booklet can serve as a reminder to the public and take encouragement from the global collaborative efforts in reducing the thinning of the ozone layer protection and bringing down the planet's global temperature.

And so, let us all work together in this mission for the betterment of the planet and humanity for many generations to come.

**Martinah Binti Haji Tamit**

.....  
Director  
Department of Environment, Parks and Recreation  
Ministry of Development

# INTRODUCTION

Life on Earth would not be possible without sunlight. However, the energy emanating from the sun would be too much for Life on Earth to prosper were it not for the ozone layer. The ozone layer acts as Earth's "invisible shield" by filtering out the sun's harmful UV rays and preventing damage to human health, crops, marine life, and even construction materials.

Therefore, when scientists discovered that ozone-depleting substances (ODSs), used in aerosols and cooling appliances such as refrigerators and air-conditioners, were causing a hole in this protective shield, unanimous global support and actions came together. Governments, scientists and industries worked together to cut out 99 per cent of all ozone-depleting substances under the Vienna Convention for the Protection of the Ozone Layer and its subsequent Montreal Protocol on Substances that Deplete the Ozone Layer. As a result, the ozone layer is gradually healing.

But the work of the Montreal Protocol is not over yet. It was discovered that the alternatives used to replace ozone-depleting substances named hydrofluorocarbons (HFCs) were potential gases with high global warming potential (GWP) values and ones that contribute to climate change. Thus, under the Protocol's new Amendment called Kigali Amendment, global efforts are also dedicated towards phasing down hydrofluorocarbons and phasing them down could reduce global warming by up to 0.4°C this century.

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**ABCi**

**AUTHORITY FOR BUILDING CONTROL AND CONSTRUCTION INDUSTRY**

**BCM**

**BROMOCHLOROMETHANE**

**CFCs**

**CHLOROFLUOROCARBONS**

**CO<sub>2</sub>**

**CARBON DIOXIDE**

**DME**

**DEPARTMENT OF MECHANICAL AND ELECTRICAL SERVICES**

**FRD**

**FIRE AND RESCUE DEPARTMENT**

**GHGs**

**GREENHOUSE GASES**

**GWP**

**GLOBAL WARMING POTENTIAL**

**HBFCs**

**HYDROBROMOFLUOROCARBONS**

**HCs**

**HYDROCARBONS**

**HCFCs**

**HYDROCHLOROFLUOROCARBONS**

**HFCs**

**HYDROFLUOROCARBONS**

**HFO**

**HYDROFLUOROOLEFIN**

**IBTE**

**INSTITUTE OF BRUNEI TECHNICAL EDUCATION**

**JASTRe**

**JABATAN ALAM SEKITAR, TAMAN DAN REKREASI**

**NH<sub>3</sub>**

**AMMONIA**

**NOU**

**NATIONAL OZONE UNIT**

**O<sub>2</sub>**

**OXYGEN**

**O<sub>3</sub>**

**OZONE**

**ODP**

**OZONE DEPLETING POTENTIAL**

**ODS**

**OZONE DEPLETING SUBSTANCES**

**RAC**

**REFRIGERATION AND AIR-CONDITIONING**

**RCED**

**ROYAL CUSTOMS AND EXCISE DEPARTMENT**

**SED**

**SUSTAINABLE ENERGY DIVISION**

**UV**

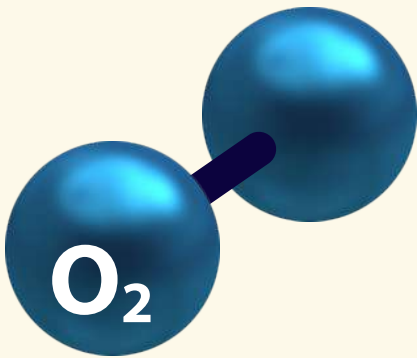
**ULTRAVIOLET**

# **LIST OF ABBREVIATIONS**

# THE FORMATION OF OZONE

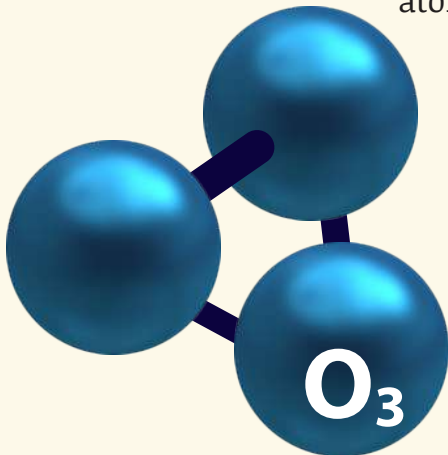
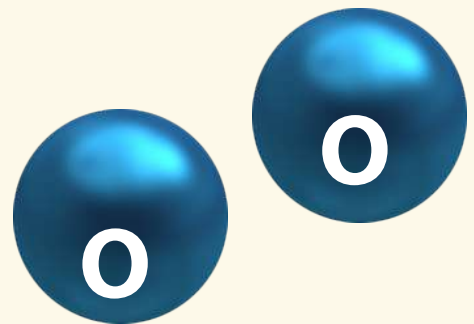
Here's what happens when ozone is formed:

**1** It started with  
*one oxygen atom*



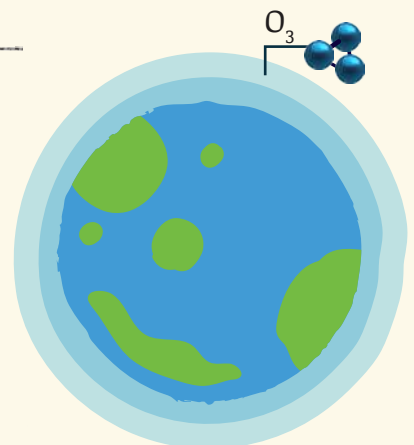
**2** *two oxygen atoms*  
makes up the oxygen ( $O_2$ ) that we breathe.

**3** *Sun UV Rays*  
break down oxygen that we breathe into two oxygen atoms.



**4** *ozone ( $O_3$ ) is formed*  
when one oxygen atom combines with oxygen that we breathe.

**5** *ozone is made up*  
of **three** oxygen atoms. In the atmosphere, it makes up a layer that surrounds the Earth.



## PERSON IN FOCUS



# Christian Friedrich Schönbein

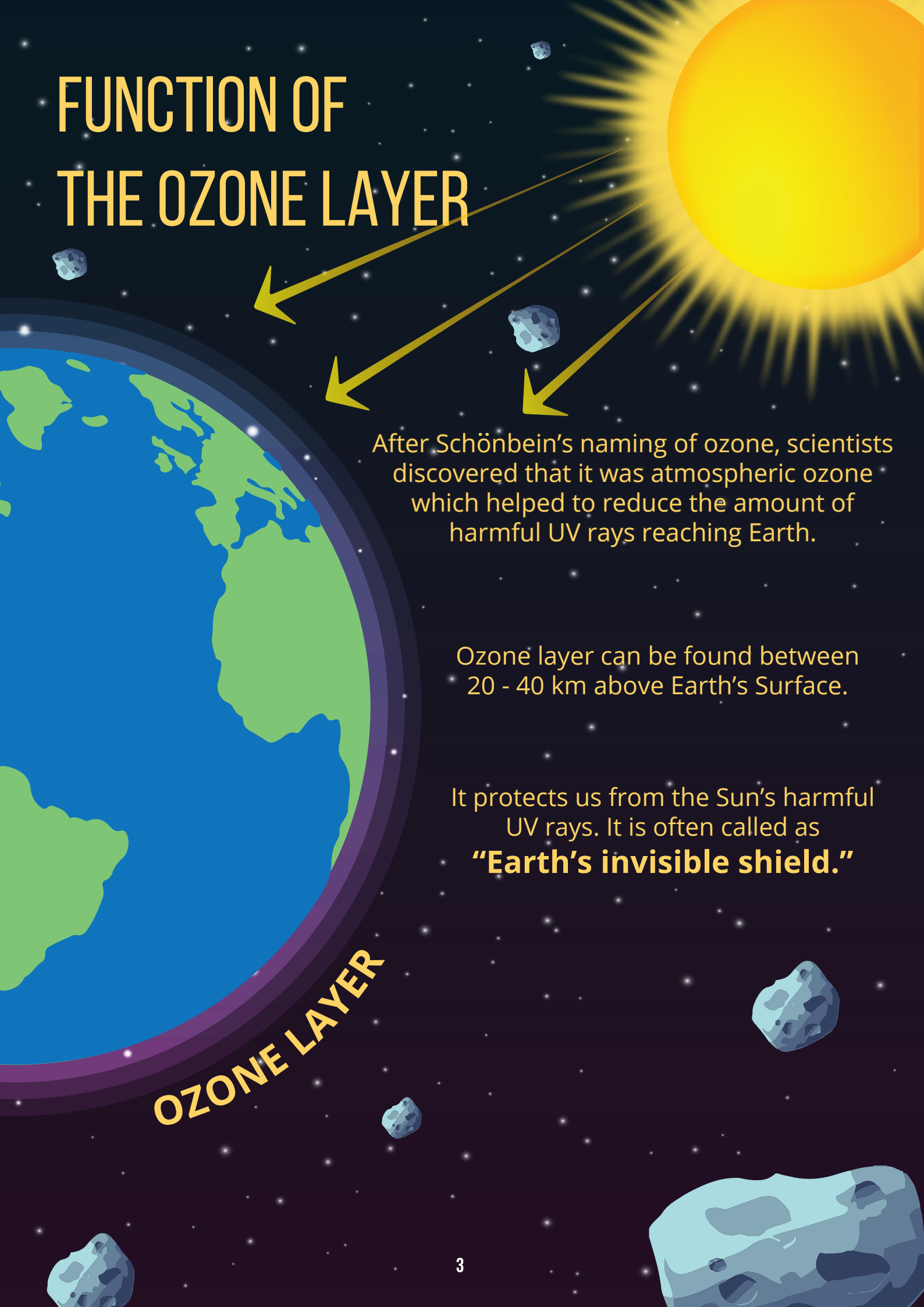
## Swiss Chemist

18 October 1799 - 29 August 1868

### Did you know?

- ★ In 1839, he was thought to be first in discovering ozone molecules.
- ★ In his experiments, he noticed a strange smell that was similar to burning electrical wires.
- ★ He named the distinctive smell "**ozone**", originated from the Greek term "ozein" meaning to "smell".

# FUNCTION OF THE OZONE LAYER



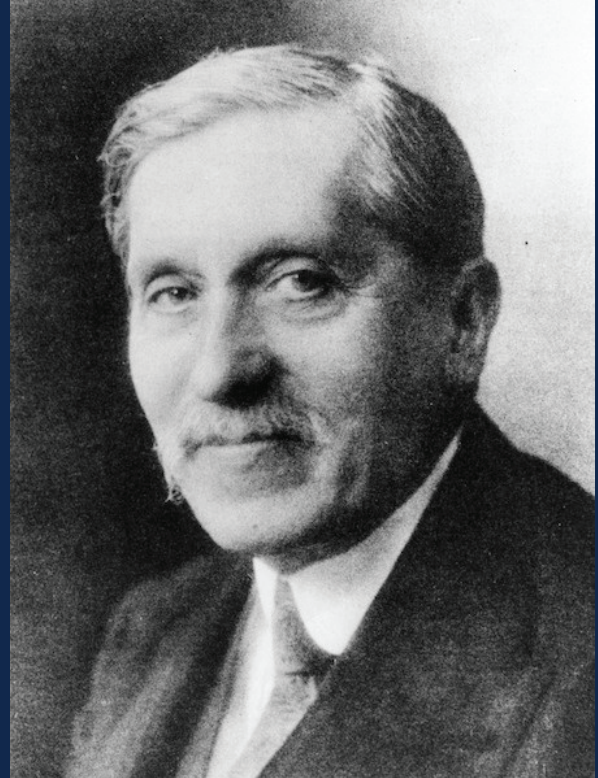
After Schönbein's naming of ozone, scientists discovered that it was atmospheric ozone which helped to reduce the amount of harmful UV rays reaching Earth.

Ozone layer can be found between 20 - 40 km above Earth's Surface.

It protects us from the Sun's harmful UV rays. It is often called as **"Earth's invisible shield."**

OZONE LAYER

## PEOPLE IN FOCUS



**HENRI  
BUISSON**

**&**

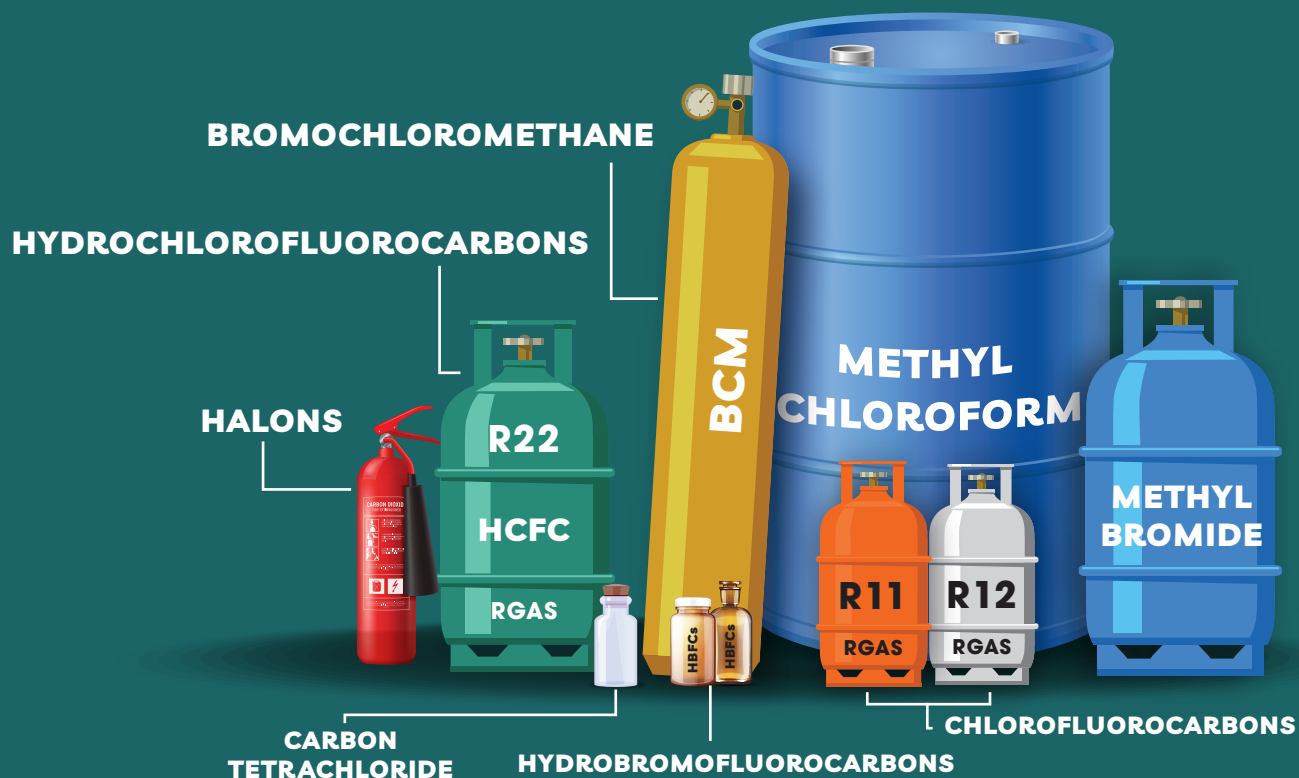
**CHARLES  
FABRY**

### FRENCH SCIENTISTS

In **1913**,  
they carried out the first experiments  
to measure ozone.  
They are credited with the actual discovery of  
**Ozone Layer.**

# DEPLETION OF OZONE LAYER

But the Earth's "invisible shield" is threatened by man-made chemicals that makes the ozone layer thinner. This is called **Ozone Depletion**.



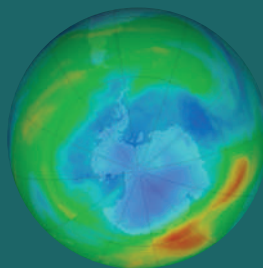
These chemicals are collectively known as **Ozone Depleting Substances (ODS)**.

## 1974



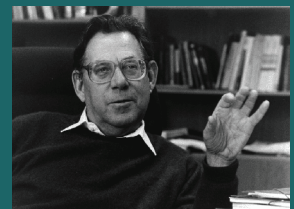
Two scientists at the University of California, published an article that the ozone layer is threatened by man-made chemicals called chlorofluorocarbon (CFC).

## 1985



After being widely attacked by the chemical industry, their work was vindicated when a group of scientists discovered that atmospheric CFCs had created an "ozone hole" over Antarctica.

## 1995



Scientists Mario Molina (top left), Sherwood Rowland (top right) and Paul Crutzen (bottom) were jointly awarded a Nobel Prize in Chemistry "for their work in atmospheric chemistry, particularly concerning the formation and the end of decomposition of ozone."

# ARE YOU CAUSING OZONE DEPLETION?



CHEMICAL NAME:  
**HCFC-141b**  
Blowing agent in foam for sandwich panels, refrigerator insulation panel and furniture



CHEMICAL NAME:  
**HCFC-123 & HALON**  
Fire extinguishing agent in the portable fire extinguisher

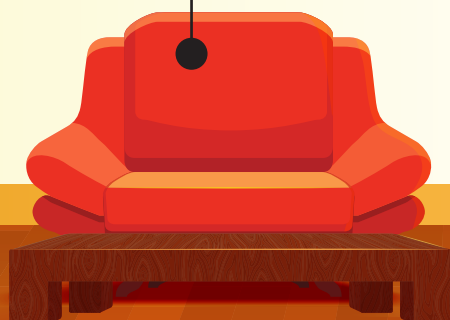


CHEMICAL NAME:  
**CFC-12 & HCFC-22**  
Refrigerant in air-conditioning units and refrigerators

ALTERNATIVES:  
**FOAM PRODUCTS**  
+ CARBON DIOXIDE  
+ METHYL FORMATE /METHYLAL  
+ CYCLOPENTANE  
+ HFC-245fa, HFC-365mfc/  
HFC227ea

ALTERNATIVES:  
**PORTABLE FIRE EXTINGUISHERS**  
+ DRY CHEMICAL  
+ AQUEOUS FILM FORMING FOAM  
+ WATER-BASED  
+ CARBON DIOXIDE  
+ DRY POWDER

ALTERNATIVES:  
**AIR-CONDITIONING UNITS**  
+ R-290 (PROPANE)  
+ HFC-32  
+ R-410A  
+ R-152A  
+ R-744 (CO<sub>2</sub>)  
+ HFO- 1234yf



# EFFECTS FROM OZONE DEPLETION



## THINNING OF OZONE LAYER

Allows more harmful ultraviolet radiations (UV rays) to reach the Earth's surface.

## HUMAN HEALTH

Humans are more vulnerable to risks of skin cancer and eye cataracts. The production of Vitamin D that helps to protect and repair skin can also be affected.



## ENVIRONMENT

Plants, animals and microbes found in natural ecosystems can be harmed, disturbing 'ecosystem services' such as clean air and clean water.

## PLANT CROPS

Higher levels of UV rays may disrupt the distribution of nutrients and affect the plants' systems that reduce or repair damages. This may lead to a substantial reduced crop production.



## LIFE BELOW WATER

Microorganisms, animals and plants in the ocean is vital for oxygen production and their roles across the food web. Increased exposure to UV rays may affect the whole food webs, threatening biodiversity and ecosystem services.

# HOW TO PROTECT YOURSELF FROM UV RAYS

## USE AN UMBRELLA

Seek shade whenever possible. Playing in shaded areas can avoid about 80% of UV rays.

## WEAR HATS

It helps to protect the delicate skin of your face and ears.

## WEAR SUNGLASSES

To protect your eyes from UV rays damage.

## WEAR LONG SLEEVE

Wear clothes that can protect your skin. A long-sleeve shirt can protect your arms.

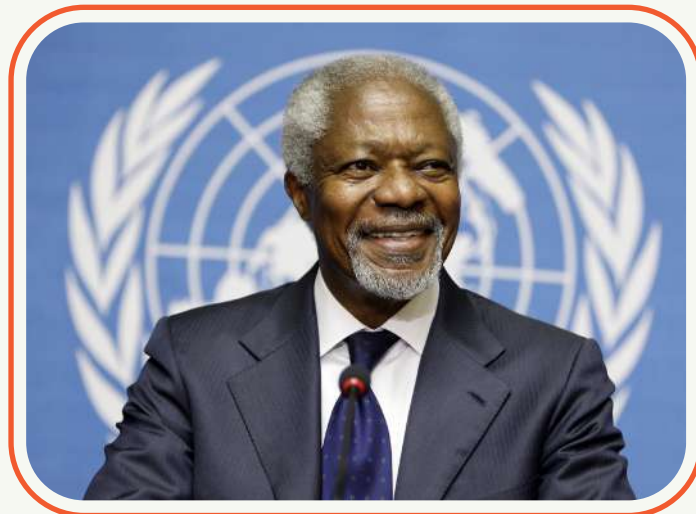
## WEAR SUNSCREEN

With at least SPF-30 and 15 minutes before you will be in the sun. Re-apply it every 2 hours.

# International Treaties for Ozone Layer Protection

## A History

**PERSON IN FOCUS**



“Montreal Protocol is  
perhaps the single most successful international  
environmental agreement to date.”

**KOFI ANNAN**

Former United Nations Secretary-General  
8 April 1938 - 18 August 2018

# 1985

## VIENNA CONVENTION FOR THE PROTECTION OF THE OZONE LAYER

Adopted in 1985, it was aimed to combat activities responsible for ozone depletion through research, observation and information exchange among nations.



# 1987

## MONTREAL PROTOCOL ON SUBSTANCES THAT DEplete THE OZONE LAYER

Designed to protect the ozone layer by phasing out the consumption and production of ozone depleting substances (ODS). It was signed on 16 September 1987 and celebrated as **WORLD OZONE DAY** every year.



# 1990

## LONDON AMENDMENT

Required complete phase out of chlorofluorocarbons (CFCs), halons, carbon tetrachloride and methyl chloroform.



# 1992

## COPENHAGEN AMENDMENT

Added hydrochlorofluorocarbons (HCFCs), hydrobromofluorocarbons (HBFCs) and methyl bromide to be phased out for developed countries.



# 1997

## MONTREAL AMENDMENT

Hydrochlorofluorocarbons (HCFCs), methyl bromide to be phased out for developing countries.



# 1999

## BEIJING AMENDMENT

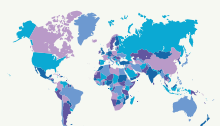
Added bromochloromethane to be phased out.



# 2015

## UNIVERSAL RATIFICATION

All countries in the United Nations ratified to Montreal Protocol, bringing to **197 Parties** altogether.



# 2019

## KIGALI AMENDMENT

Added hydrofluorocarbons (HFCs) to be phased down as they were adopted as alternatives to ODS but are potent greenhouse gases, damaging the Earth's climate.



# BRUNEI DARUSSALAM AND MONTREAL PROTOCOL



*Did you know?*

The **Department of Environment, Parks and Recreation (JASTRe)**, Ministry of Development is the national focal agency to the Vienna Convention and its protocol namely the Montreal Protocol on Substances that Deplete the Ozone Layer. Notably under this treaty, Parties have obligations on ODS phase-out such as annual reporting of ODS data, implementing national licensing systems to control ODS imports and exports, providing trainings to technicians as well as customs officers and awareness outreach in order to aid in the healing of the ozone layer.

This certainly aligns with the Department's mission to protect and conserve the environment so as to ensure it remains clean, green and safe.

JASTRe realizes that it is neither a small nor easy feat in trying to protect the environment, and has collaborated with relevant stakeholders specifically Authority for Building Control and Construction Industry (ABCI), Department of Mechanical and Electrical Services (DME), Royal Customs and Excise Department (RCED), Fire and Rescue Department (FRD), Institute of Brunei Technical Education (IBTE) as well as Sustainable Energy Division (SED) under Ministry of Energy in order to meet the commitments stated under the Montreal Protocol.

# ROLES OF EACH STAKEHOLDERS

## NATIONAL OZONE UNIT



The National Ozone Unit (NOU) was established in 1998, under the administration of JASTRe.

They are responsible for the day-to-day operations related to the implementation of the Montreal Protocol.

It serves as the regulatory body in Brunei for the control of the consumption of ODS and ODS alternatives.

It is also the focal point for stakeholders, both governmental and private entities, and coordinates to implement and monitor the Montreal Protocol activities at the national, regional, and international levels.



# ROLES OF EACH STAKEHOLDERS

## ROYAL CUSTOMS AND EXCISE DEPARTMENT



Regulating the import and export of ODS and ODS alternatives through the enforcement of the Application Permit system and strengthening the capacity of enforcement officers through various training programmes.



## FIRE AND RESCUE DEPARTMENT

Mandated to deal with matters on fire hazards and fire safety which includes handling, transport, storage, import and dispensing of flammable materials. They will play a crucial role in facilitating the safe introduction of flammable refrigerants.

# ROLES OF EACH STAKEHOLDERS

## AUTHORITY FOR BUILDING CONTROL AND CONSTRUCTION INDUSTRY



Mandated to provide approvals for any building and construction work across all sectors. This also involves the registration of products including RAC equipment especially for those who wish to supply and procure RAC equipment for government projects.

The Building Guidelines and Requirements as well as Industrial Development Guidelines Brunei Darussalam also serve as guidelines aimed at promoting good quality building that is structurally safe and meet the required health, environmental, fire, protection, sustainable and other criteria.



## DEPARTMENT OF MECHANICAL AND ELECTRICAL SERVICES

Established under the Public Works Department to be responsible in developing specifications for mechanical and electrical appliances, including RAC equipment for government tenders and quotations.

Given that the installation work for RAC equipment in Brunei is dominated by government contracts, they play a vital role in phasing out ODS and HFC-based equipment which would avoid significant consumption of HCFC and HFC and promote low-GWP alternatives in the future.

# ROLES OF EACH STAKEHOLDERS

## INSTITUTE OF BRUNEI TECHNICAL EDUCATION



In collaboration with JASTRe, they are selected as National Training Center for RAC servicing trainings that are conducted by National Master Trainers.

As a statutory board under the purview of Ministry of Education, the Ministry has long been an important partner in the training and certification of servicing technicians In Brunei.



## SUSTAINABLE ENERGY DIVISION MINISTRY OF ENERGY

Responsible for the policy development and implementation of all core sustainable energy initiatives and projects, in particular energy efficiency and conservation as well as renewable energy projects, which will help to reduce energy consumption and promote more efficient energy use nationwide.

Moreover, the Ministry's Energy Efficiency (Standard and Labelling) Order, 2021 will prohibit the use and importation of inefficient technologies including RAC equipment, particularly room air-conditioners.

In fact, the Department's collaboration with RCED plays a crucial role in Brunei's ODS consumption as imports and exports of those ODS are controlled under the Customs Act – Prohibition and Restriction on Imports and Exports (Amendment) Order, 2006.

**Then, 1997 - 2010**  
**Can I Import...**

|                      |
|----------------------|
| BCM                  |
| CFC                  |
| HBFC                 |
| HCFC                 |
| Halon                |
| Carbon Tetrachloride |
| Methyl bromide       |
| Methyl Chloroform    |

**YES**

**Now, 2011 Onwards**  
**Can I Import...**

|                      |
|----------------------|
| BCM                  |
| CFC                  |
| HBFC                 |
| Halon                |
| Carbon Tetrachloride |
| Methyl bromide       |
| Methyl Chloroform    |

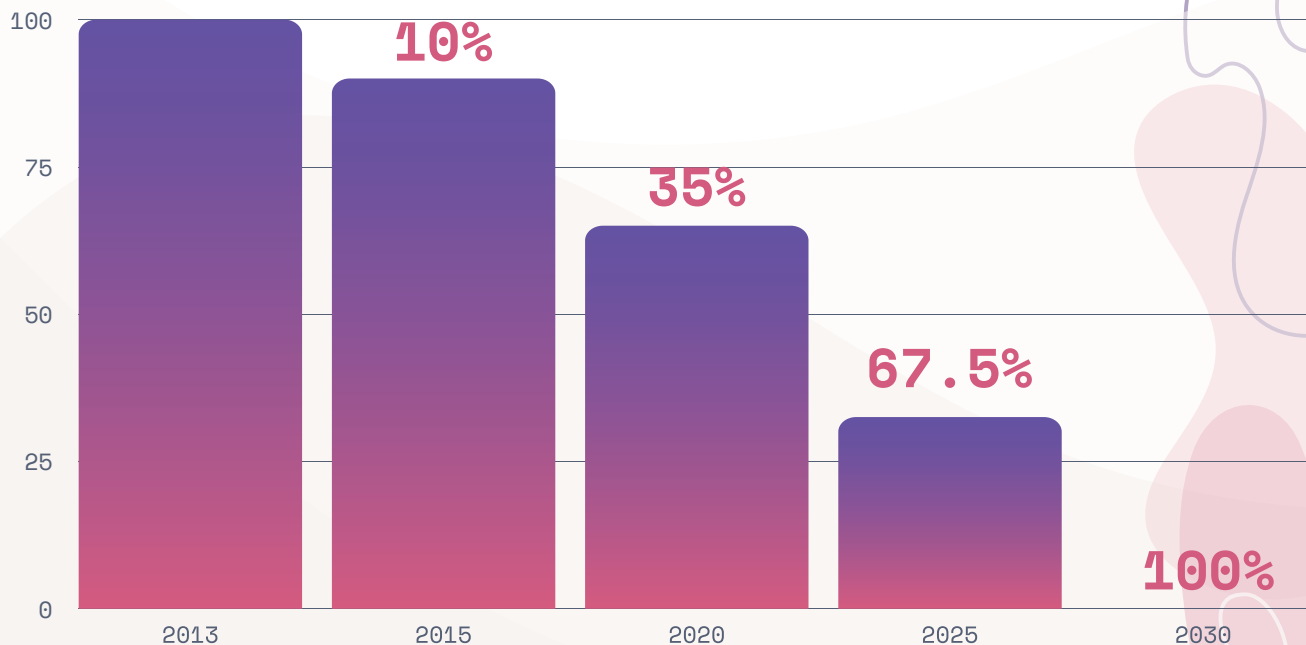
**NO**

|      |
|------|
| HCFC |
|------|

**Only companies  
registered under  
JASTRe with a  
HCFC import  
history before the  
year 2012**

# BRUNEI DARUSSALAM'S HCFC PHASE-OUT SCHEDULE

The remaining ODS, HCFC-22 will be phased out following the graph below:



Free consumption at base level starting from 1 January 2013 (average import in 2009 - 2010 )

10% Consumption Reduction by 2015  
35% Consumption Reduction by 2020  
67.5% Consumption Reduction by 2025

**0%** Total HCFC phase-out by 2030  
(2.5% for servicing purposes only)

**There are THREE approaches to phase out HCFC**

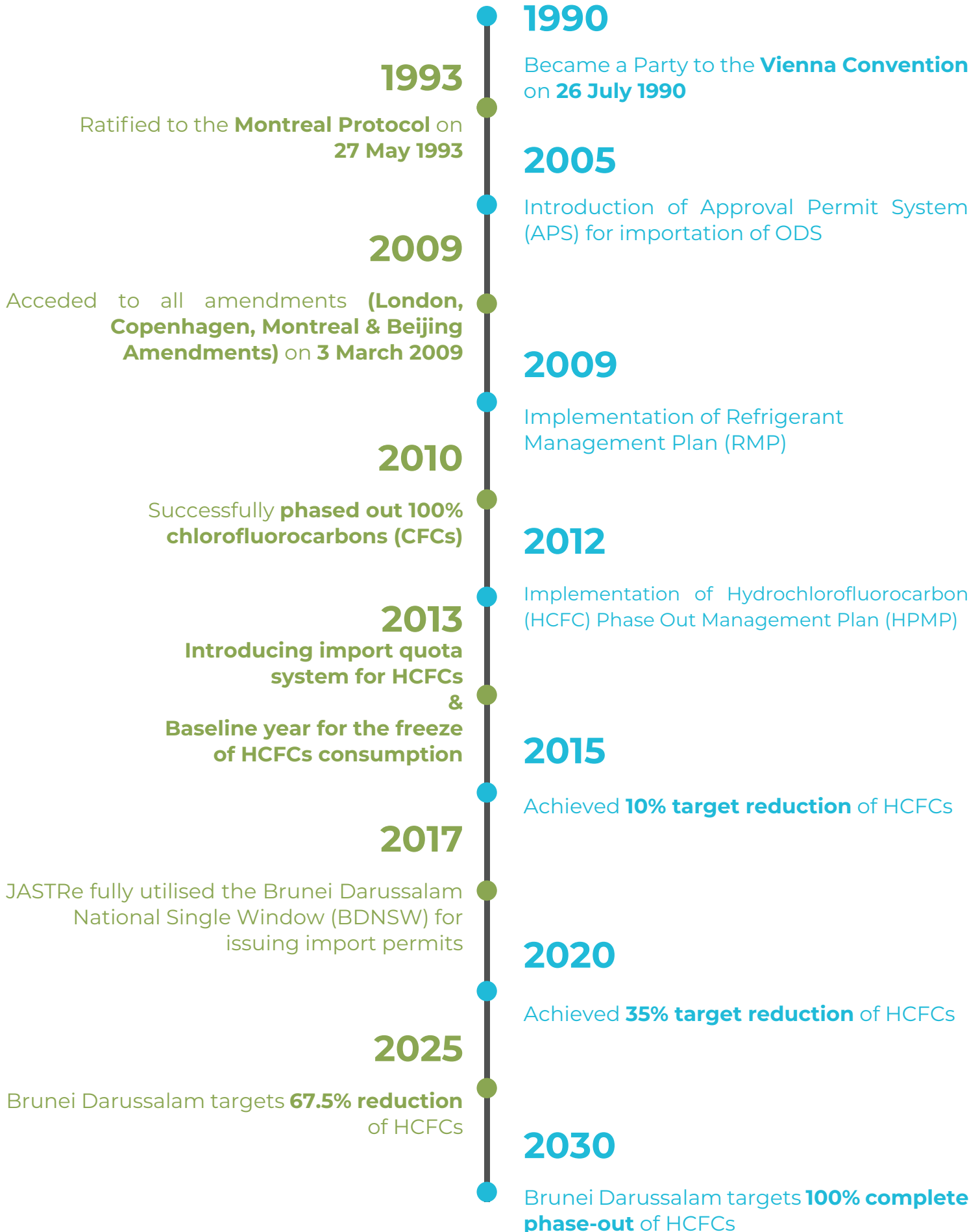
**1**  
**Limit the  
Supply of  
HCFC**

**2**  
**Limit  
New Demand  
of HCFC**

**3**  
**Reduce Demand  
of HCFCs for  
Servicing Existing  
Equipment**



# B R U N E I DARUSSALAM'S MILESTONES



# GRADUAL TRANSITION OF GASES UNDER MONTREAL PROTOCOL

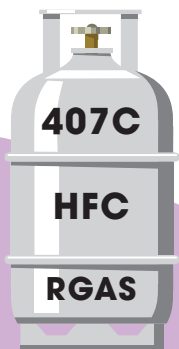


**CFCs**  
Ozone Depleting  
Substances

Controlled under  
the Montreal Protocol



**HCFCs**  
Ozone Depleting  
Substances



**HFCs**  
Non-Ozone Depleting  
Substances

Kigali Amendment



**Lower GWP  
alternatives**  
(e.g. CO<sub>2</sub>, NH<sub>3</sub>, HC)  
Non-Ozone Depleting  
Substances

# Kigali Amendment

With the phasing out of ODS, non-ODS alternatives have been introduced to replace the gases. These alternatives are commonly known as **Hydrofluorocarbons (HFCs)**.



## HOWEVER...

while HFCs are non-ODS, they are powerful greenhouse gases (GHGs) with high Global Warming Potential (GWP) values and can contribute to climate change.

| Type    | Gas            | GWP    | ODP   |
|---------|----------------|--------|-------|
| ODS     | CFC-12         | 10 900 | 1.0   |
|         | HCFC-22        | 1810   | 0.055 |
| HFC     | HFC-404A       | 3922   | 0     |
|         | HFC-410A       | 2088   | 0     |
|         | HFC-134a       | 1430   | 0     |
|         | HFC-32         | 675    | 0     |
| HFO     | HFO-1234yf     | 4      | 0     |
| Natural | Propane        | 3      | 0     |
|         | Carbon dioxide | 1      | 0     |



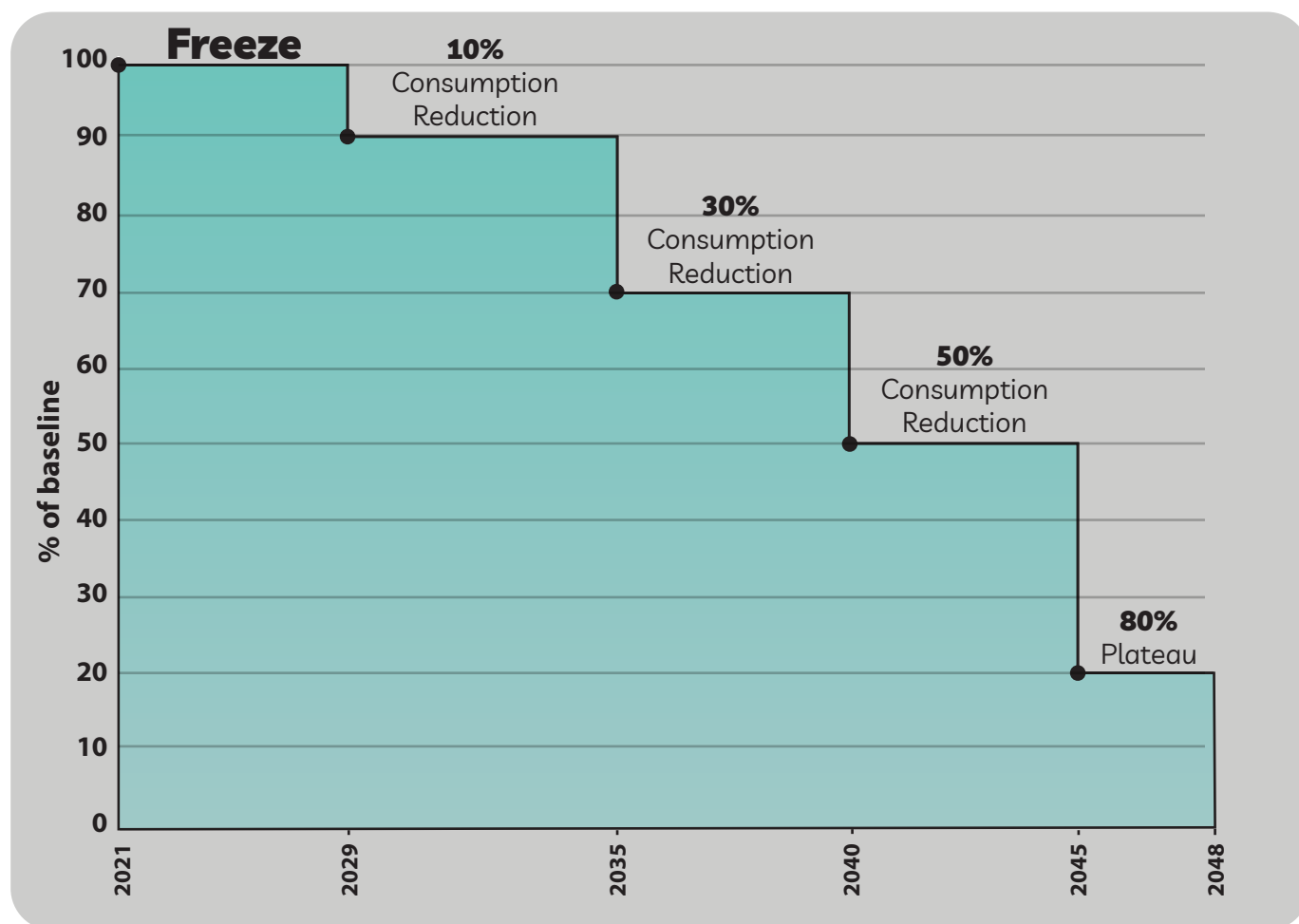
A new amendment called **Kigali Amendment** was introduced in Kigali, Rwanda. It was adopted on 15 October 2016 and entered into force in 2019.

This Amendment adds Hydrofluorocarbons to the list of substances controlled under Montreal Protocol.

# HYDROFLUOROCARBONS

## PHASE-DOWN SCHEDULE

Parties are required to gradually reduce HFC production and consumption by more than 80% in late 2040s. As Brunei Darussalam is categorised as **Article 5 - Group 1**, our phase-down schedule is as below:



A successful HFC phasedown is expected to avoid up to **0.4 °C** of global temperature rise by 2100.

### BRUNEI DARUSSALAM'S EFFORT IN SUPPORTING KIGALI AMENDMENT

Regulate HFC imports and exports under **Custom Act**

Carry out a survey to **assess country situation** in the use of HFCs

**Train technicians** in safe handling of flammable refrigerants

Draft **guidelines** in handling flammable refrigerants

Design **tracking stickers** and revise **HS codes** for monitoring

Design and distribute **awareness materials**

# SO WHAT CAN I DO TO HELP?

**Is your company  
registered under JASTRe?**



Yes! We've registered to import and supply refrigerants controlled under the Department. Here's our import permit issued by JASTRe!

**WHEN BUYING REFRIGERANTS, MAKE SURE TO BUY FROM REGISTERED IMPORTERS UNDER JASTRe.**

These refrigerant cylinders are properly verified and approved by the Department before they enter into the market.

**Hi! Do you need help in finding an air-conditioner?**



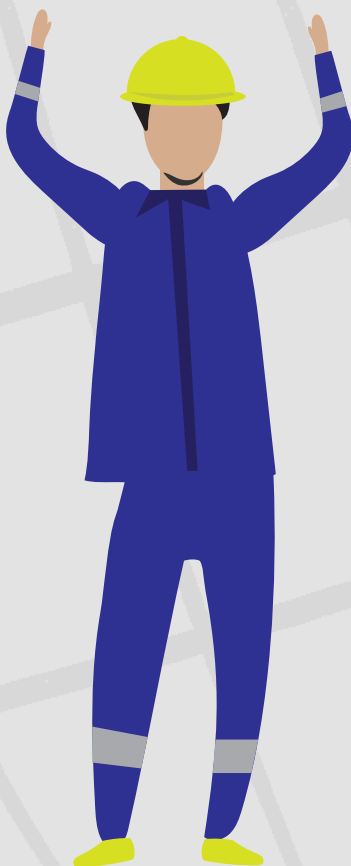
**When buying air-conditioners, consider the following:**

- 1** Does it contain or use ODS like HCFC-22?
- 2** Does it contain or use high GWP refrigerant like HFC-410A?
- 3** Make informed decisions to buy air-conditioners that are ODS-free and have low GWP to protect our ozone layer and slow down global warming.

**MY AIR-CONDITIONER  
NEEDS SERVICING!  
WHO SHOULD I CALL?**



**Call technicians who are  
trained to service  
air-conditioners.**



That's me! I've undergone trainings on good servicing practices under a certified body so that your air-conditioner has the best performance while protecting the ozone layer and slow down global warming.

**FOR HCFC-22  
CYLINDERS,  
PLEASE ENSURE  
THAT THE  
CYLINDERS HAVE  
BEEN INSPECTED  
BY JASTRe**

It means that the gas cylinders:

1

Contain HCFC-22 as stated from the labelling.

2

The HCFC-22 is 100% pure. It is not mixed with other substances which may affect your air-conditioner's performance.

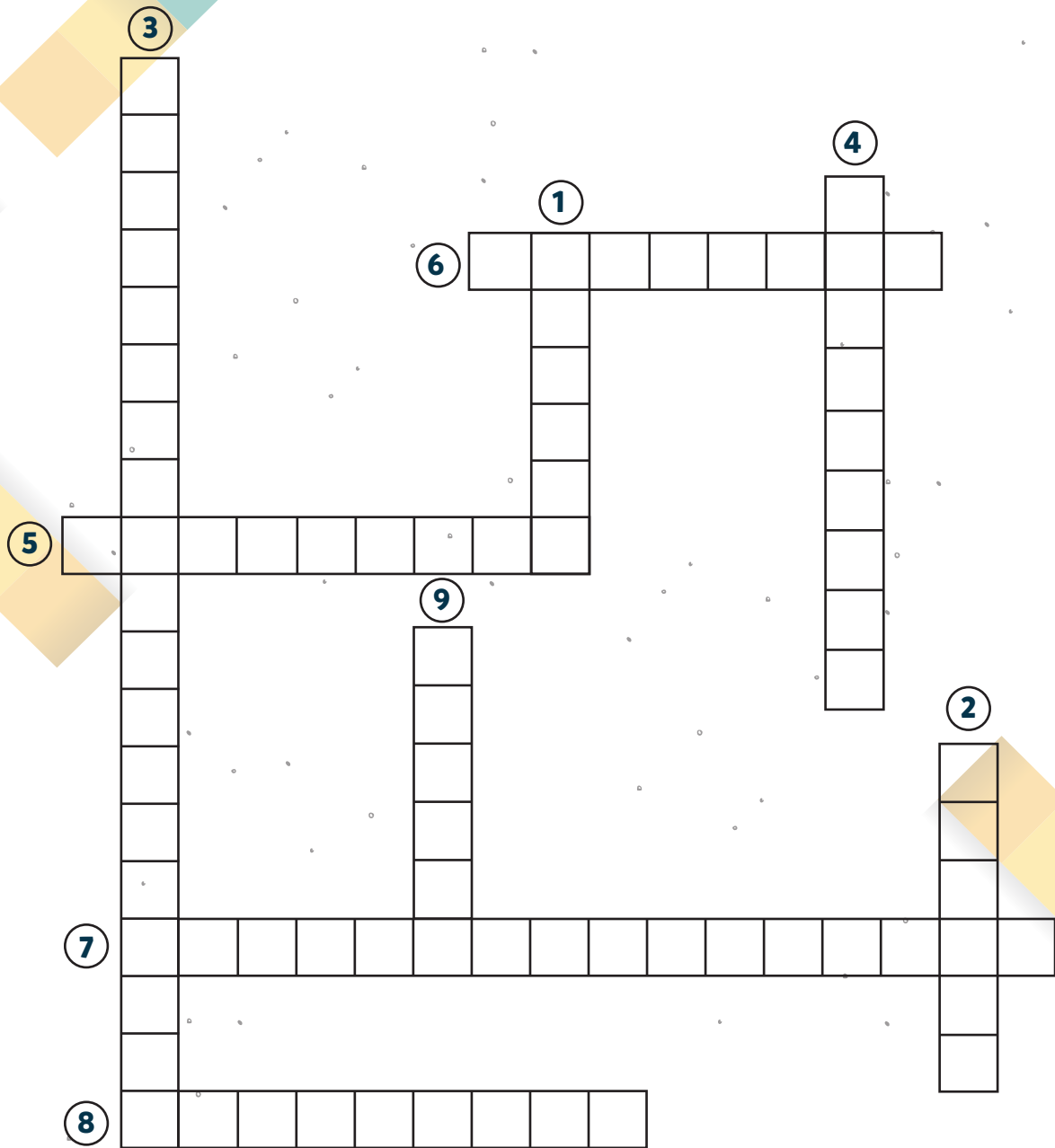
**Looking out for this sticker.**

|  | <b>SERIAL NO:</b>                                                                                                                                                                         |      |       |      |  |  |
|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------|------|--|--|
|                                                                                     | <b>PROTECT THE OZONE LAYER</b><br>CYLINDERS CERTIFIED BY<br>NATIONAL OZONE UNIT<br>DEPARTMENT OF ENVIRONMENT, PARKS AND RECREATION<br>MINISTRY OF DEVELOPMENT<br>NEGARA BRUNEI DARUSSALAM |      |       |      |  |  |
|                                                                                     | <b>DATE OF IMPORT</b>                                                                                                                                                                     |      |       |      |  |  |
|                                                                                     | <table border="1"><thead><tr><th>DAY</th><th>MONTH</th><th>YEAR</th></tr></thead><tbody><tr><td> </td><td> </td><td> </td></tr></tbody></table>                                           | DAY  | MONTH | YEAR |  |  |
| DAY                                                                                 | MONTH                                                                                                                                                                                     | YEAR |       |      |  |  |
|                                                                                     |                                                                                                                                                                                           |      |       |      |  |  |



# SOLVE THE PUZZLE!

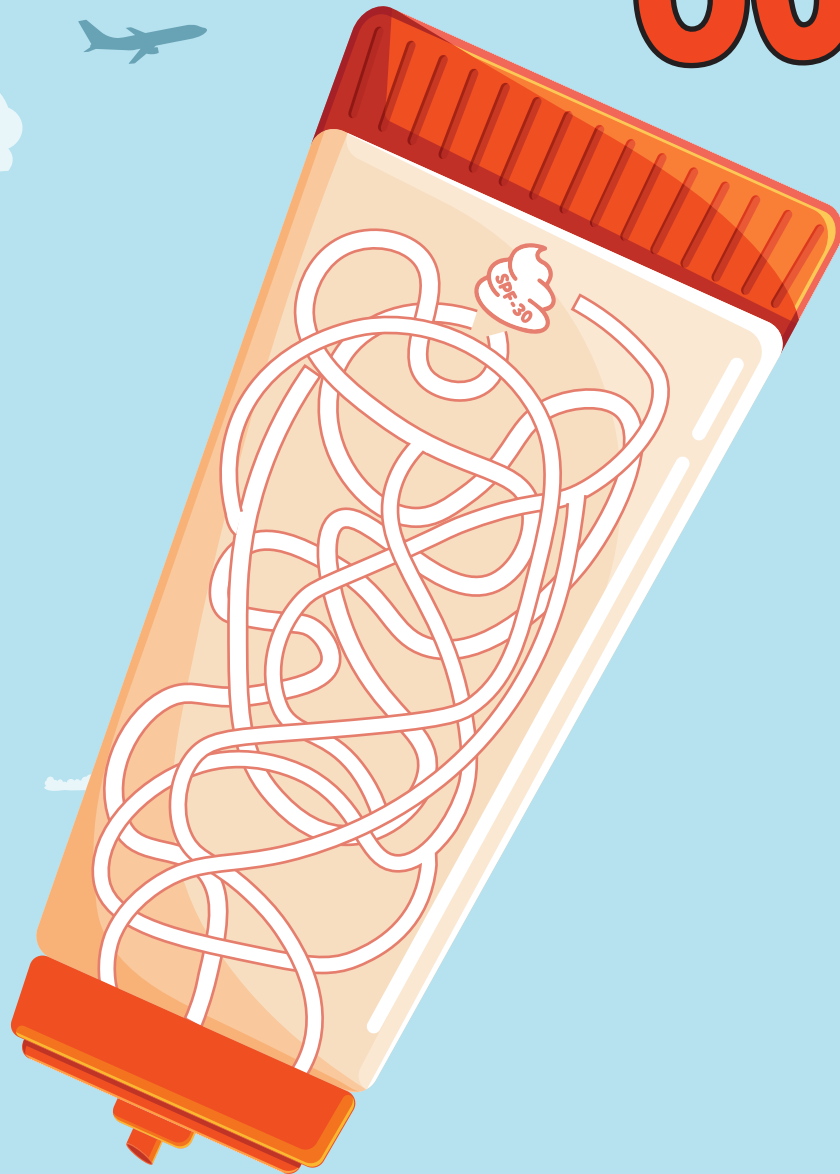
**Congratulations! Now that you have made it to the end can you find the hidden words in the puzzle below?**



1. The ozone layer is made up of three \_\_\_\_\_ atoms.
2. The ozone layer helps to protect living things from harmful \_\_\_\_\_.
3. The full name of CFCs is \_\_\_\_\_.
4. Increased UV exposure increases the risks of having eye \_\_\_\_\_.
5. Wear \_\_\_\_\_ when you spend time outdoors.
6. The Montreal Protocol on Substances that Deplete the Ozone Layer was signed in \_\_\_\_\_, Canada.
7. This country ratified the Montreal Protocol on 27 May 1993.
8. World Ozone Day is celebrated every 16 \_\_\_\_\_.
9. The latest amendment to reduce the consumption and production of Hydrofluorocarbons is called \_\_\_\_\_ Amendment.

KICALI  
 SEPTEMBER  
 BRUNEL DARUSSALAM  
 MONTREAL  
 SUNSCREEN  
 CATARACTS  
 CHLOROFUOROCARBONS  
 UV RAYS  
 OXYGEN

# **SQUEEZE THE SUNSCREEN OUT!**



**HEY GUYS, I NEED A HAND. CAN YOU  
HELP ME SQUEEZE THE SUNSCREEN  
OUT?**



Tumasek Plaza Building, Raja Isteri Pengiran Anak Saleha Road  
Bandar Seri Begawan, BA191O, Negara Brunei Darussalam  
Tel. : 673-2241262 | Fax: 673-2241290  
Website: [www.env.gov.bn](http://www.env.gov.bn)  
📧 : [@jastre.bn](mailto:jastre.bn)  
Email: [jastre.brunei@env.gov.bn](mailto:jastre.brunei@env.gov.bn)