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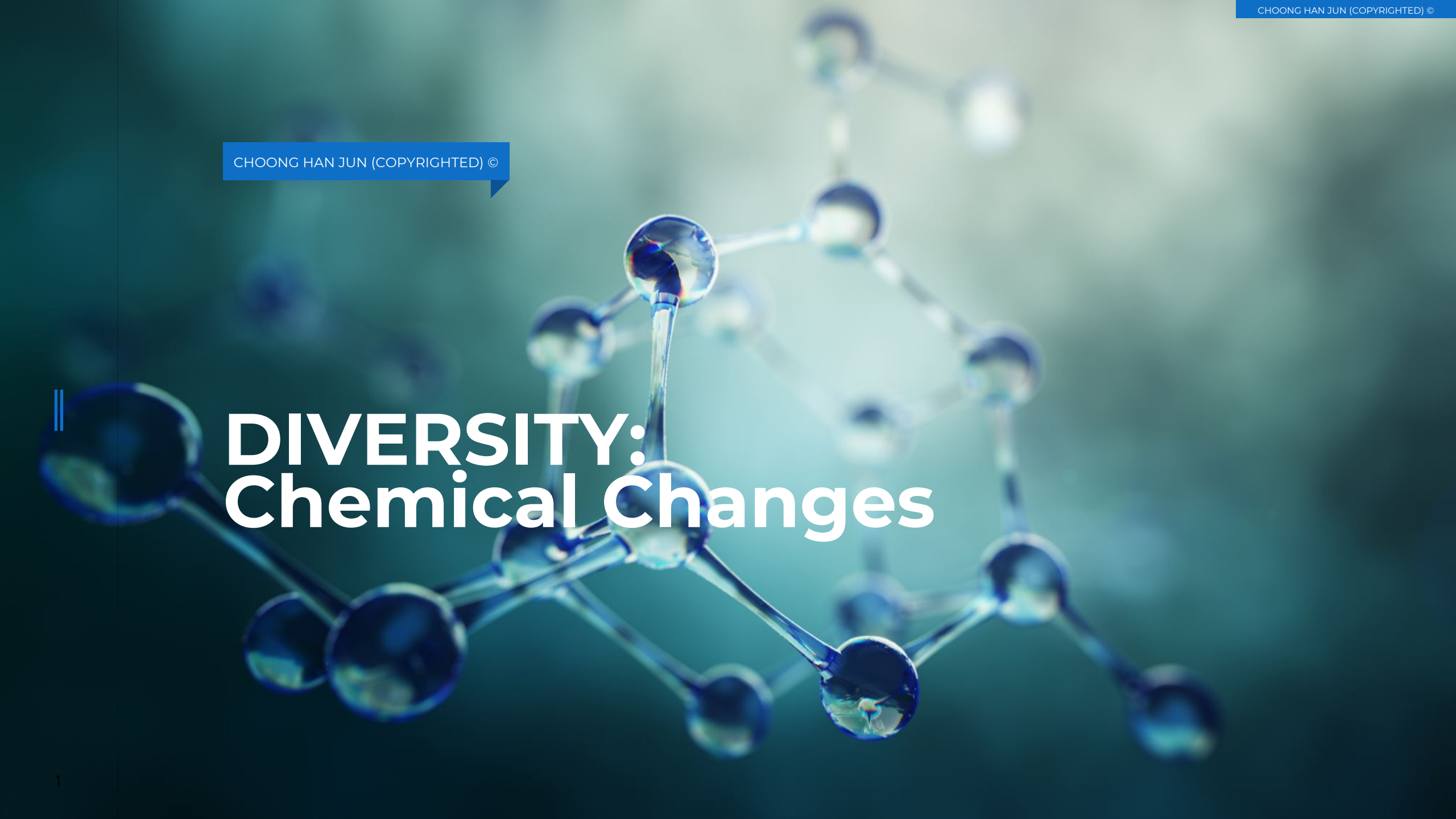

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DIVERSITY: Chemical Changes

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CHAPTER ANALYSIS

7 KEY CONCEPTS

- Identify a change which leads to formation of new product(s) as a chemical change
- Show an awareness that there are different types of chemical reactions such as combustion, thermal decomposition, oxidation and neutralization
- Use word equations to represent chemical reactions
- Investigate the changes that matter undergoes through mixing, heating, exposure to light, passing of an electric current, oxidation
- Show an awareness that chemical reactions involve a rearrangement of atoms, which are not created or destroyed
- Infer that mass is conserved during a chemical reaction
- Investigate the effect of acidic, alkaline and neutral solutions on indicators and reactions between acids and metals, acids and carbonates, acids and alkalis

1 ADVANCED CONCEPTS

- Show an awareness of how chemical reactions can benefit our lives and cause harm to our health and environment

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KEY CONCEPT

PHYSICAL & CHEMICAL CHANGES

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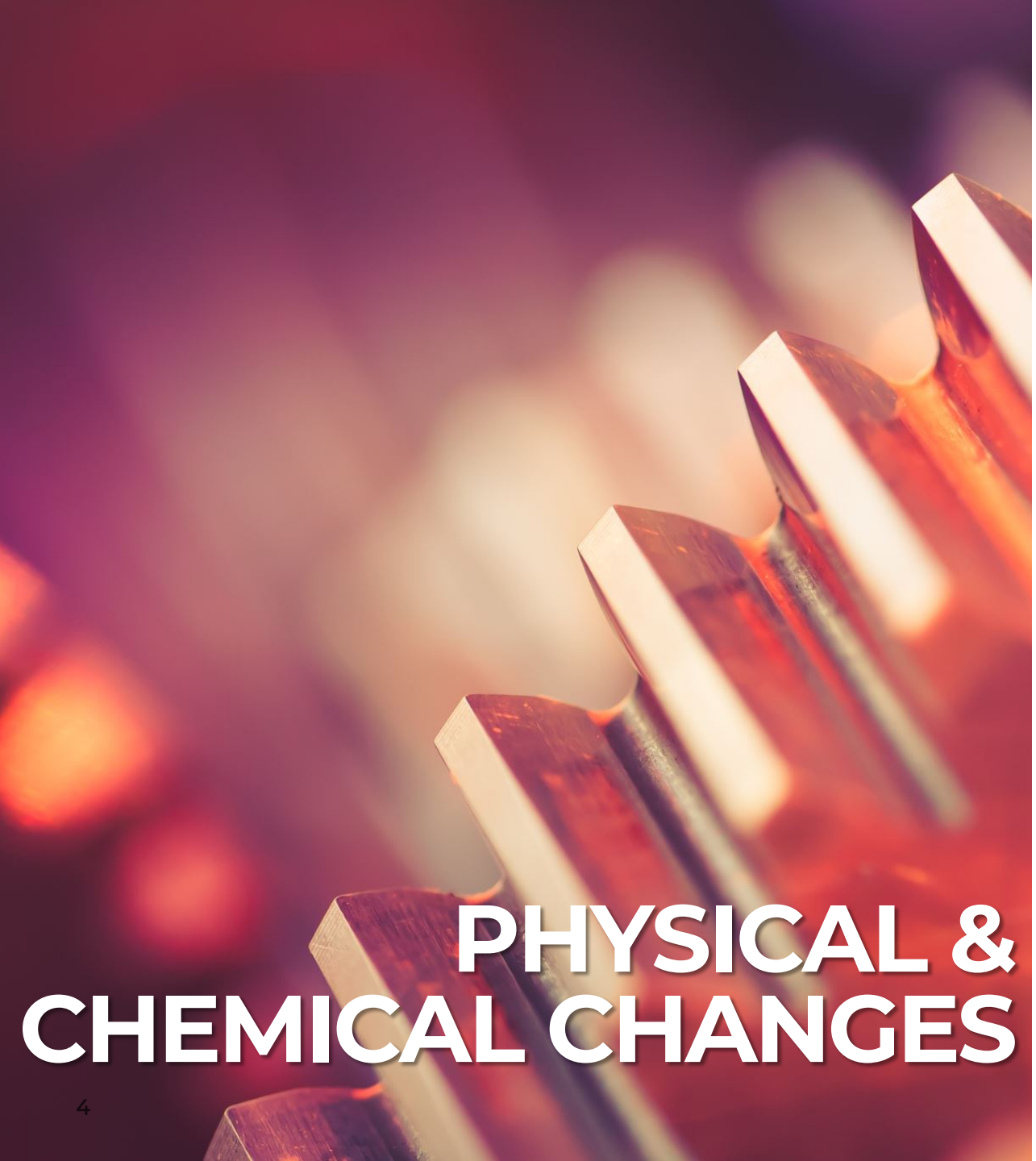

PHYSICAL & CHEMICAL CHANGES

PHYSICAL CHANGES

Definition: A physical change is a change in which no new substance is formed

Physical changes can be reversed.

Example: water changing into steam when it boils (the change can be reversed with cooling)

CHEMICAL CHANGES

Definition: A chemical change is a change in which a new substance is formed

Chemical reactions are difficult to reverse.

Representation of chemical reactions

conditions

heat

Magnesium + oxygen → Magnesium oxide

reactants — Product(s)

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KEY CONCEPT

INTERACTIONS

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MATTER & HEAT INTERACTIONS

THERMAL DECOMPOSITION

In thermal decomposition, a single substance breaks up into two or more simpler substances when it is heated.

Example:

Sugar $\xrightarrow{\text{heat}}$ **Carbon + water vapour**

COMBUSTION

In combustion, a substance reacts with oxygen when heated to form one or more new substance

Example:

Carbon + oxygen $\longrightarrow$ **Carbon dioxide + heat**

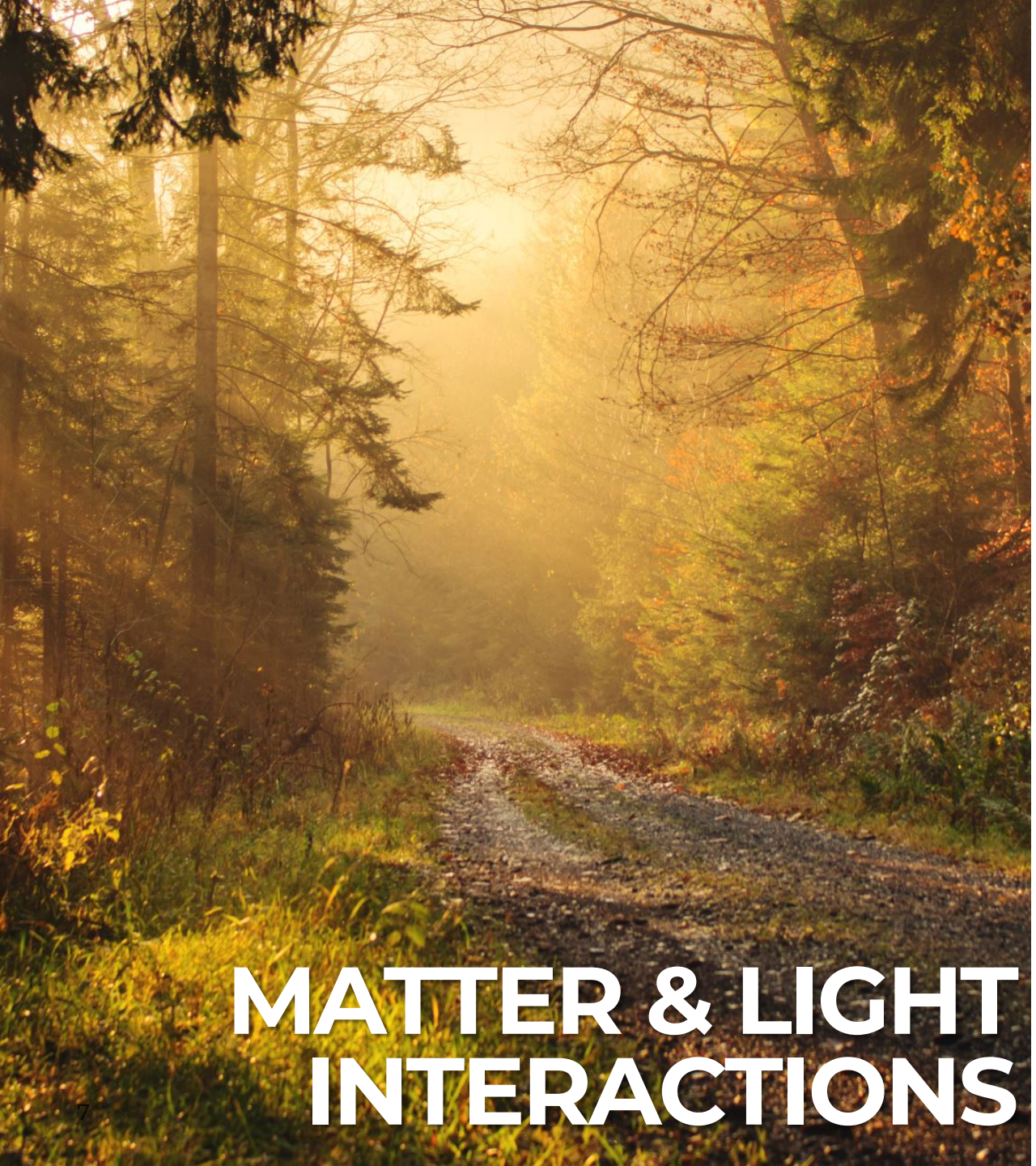
Combustion reactions include burning of fuels such as coal, natural gas and petrol.

OXIDATION

Oxidation refers to the addition of oxygen to a substance.

Example:

Iron + oxygen $\longrightarrow$ **Iron oxide (rust)**



MATTER & LIGHT INTERACTIONS

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PHOTOSYNTHESIS

Photosynthesis is the process by which green plants use light energy to make food.

Equation:

Carbon dioxide + water $\xrightarrow{\text{Light energy}}$ **Oxygen + glucose**

PHOTOGRAPHY

The coating on black and white photographic film contains silver bromide. Exposure to light decomposes the silver bromide into silver, which produces the dark areas on film.

Equation:

Silver bromide $\xrightarrow{\text{Light}}$ **Silver (grey solid) + bromide**

MATTER & ELECTRICITY INTERACTIONS

Matter can also react with electricity in reactions such as **electrolysis**. Electrolysis is used in the process of *electroplating*.

(Refer to Electrical Systems chapter for more information).

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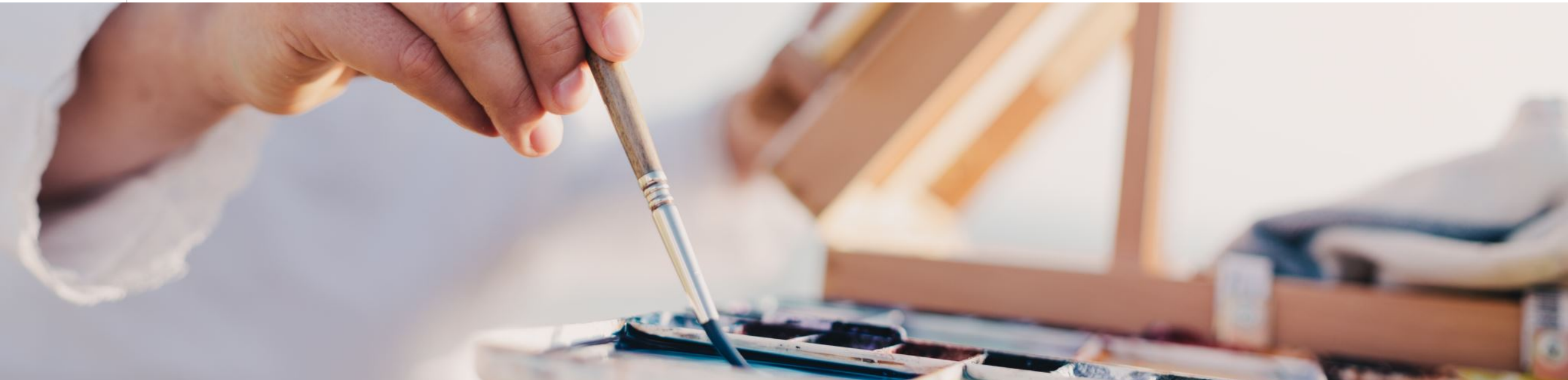
KEY CONCEPT

MIXING OF SUBSTANCES



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MIXING WITH ACIDS

ACIDS & METALS

When dilute acids are mixed with certain metals, **hydrogen gas** and a **salt** are produced.

Example

Hydrochloric acid + magnesium → **Magnesium chloride + hydrogen gas**

- Hydrochloric acid: acid
- magnesium: metal
- Magnesium chloride: salt
- hydrogen gas: gas

ACIDS & CARBONATES

When dilute acids are mixed with carbonates, **carbon dioxide gas,** a **salt** and **water** are produced.

Example

Hydrochloric acid + calcium carbonate → **Calcium chloride + carbon dioxide + water**

- Hydrochloric acid: acid
- calcium carbonate: carbonate
- Calcium chloride: salt
- carbon dioxide: CO_2
- water: water

ACIDS & ALKALIS

When dilute acids are mixed with alkalis, a **neutralization reaction** occurs, producing a **salt** and **water**.

Example

Hydrochloric acid + sodium hydroxide → **Sodium chloride + water**

- Hydrochloric acid: acid
- sodium hydroxide: alkali
- Sodium chloride: salt
- water: water

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KEY CONCEPT

ACIDS, ALKALIS, & INDICATORS

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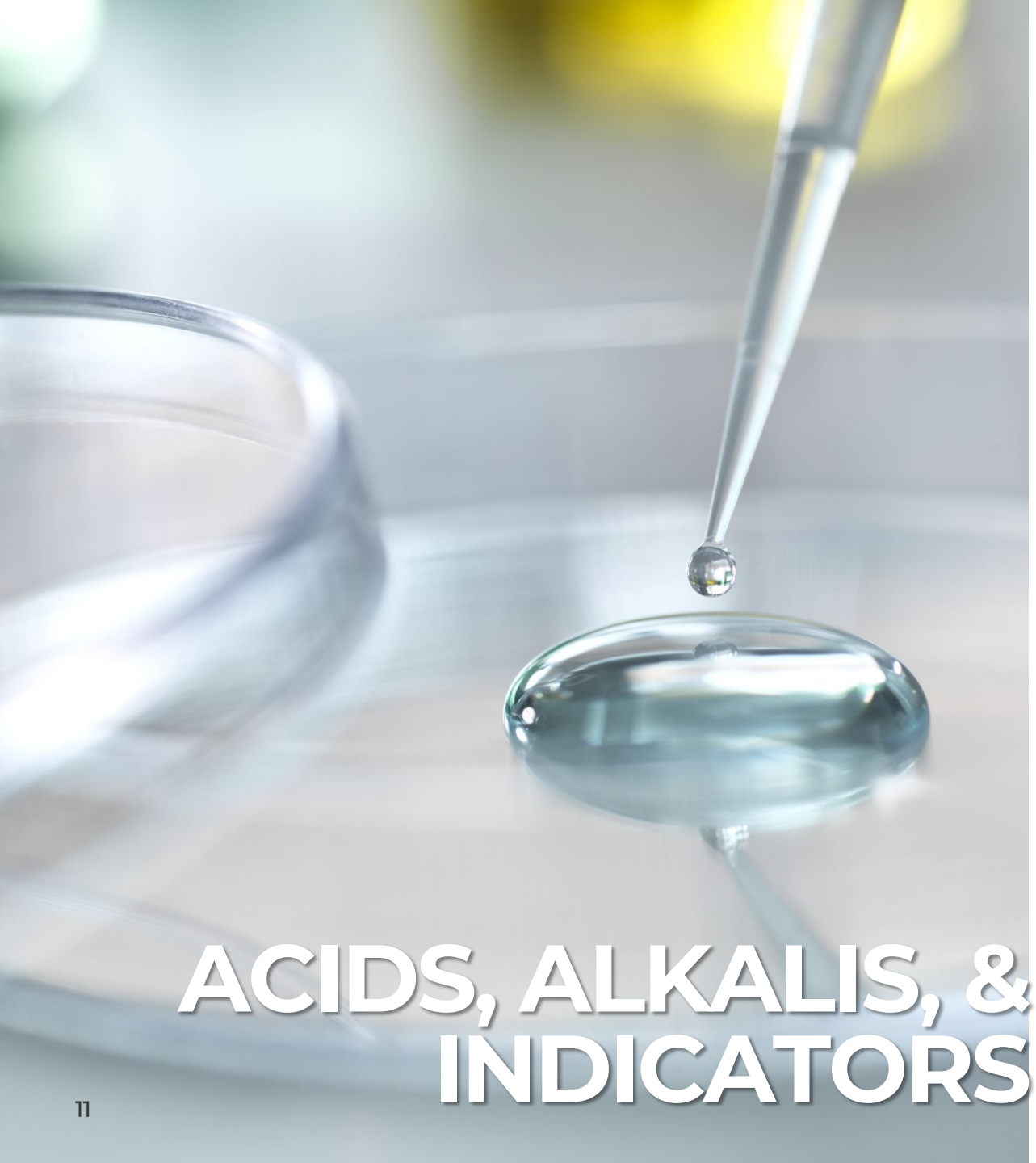
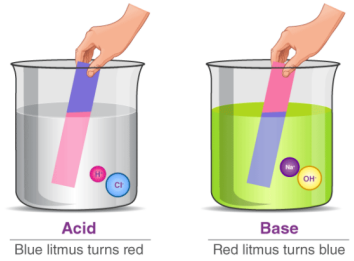


ACIDS, ALKALIS, & INDICATORS

In order to tell whether a solution is an acid or an alkali, we use **indicators.**

Definition: Indicators are substances that show one colour in acids and another in alkalis

Litmus indicator

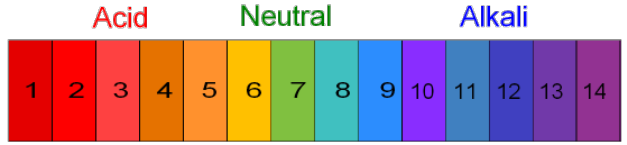


Natural indicators

- Juice extracted from red cabbage is pink in acids and green in alkalis
- Hydrangea flowers are pink when grown in alkaline soil and blue when grown in acidic soil

Universal indicator

The indicator changes into different colours when it is added to different substances. Each colour corresponds to a pH value between 0 and 14 (pH scale)



pH meter

pH meters are more accurate than universal indicators.
The electrode on the meter is dipped into a solution and the pH value is read from the meter.

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KEY CONCEPT

PARTICULATE MODEL FOR CHEMICAL CHANGES

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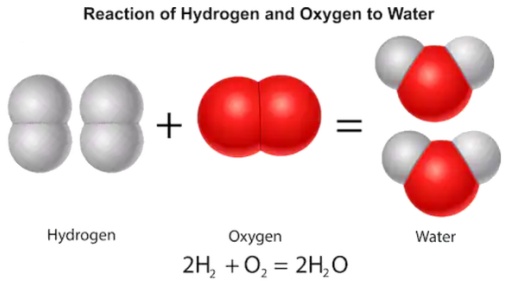
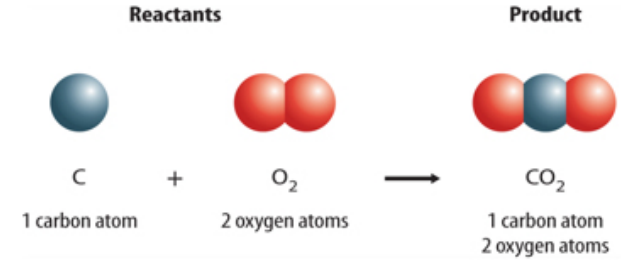
PARTICULATE MODELS

Burning hydrogen



Burning carbon



What happens to matter in a chemical reaction?

No of atoms of reactants = no of atoms of products

Atoms are NOT created or destroyed in a reaction; they are only **rearranged**.

Because all the numbers of atoms are the same, the mass is also the same.

Mass of reactants = mass of products

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KEY CONCEPT

EFFECTS OF CHEMICAL REACTIONS

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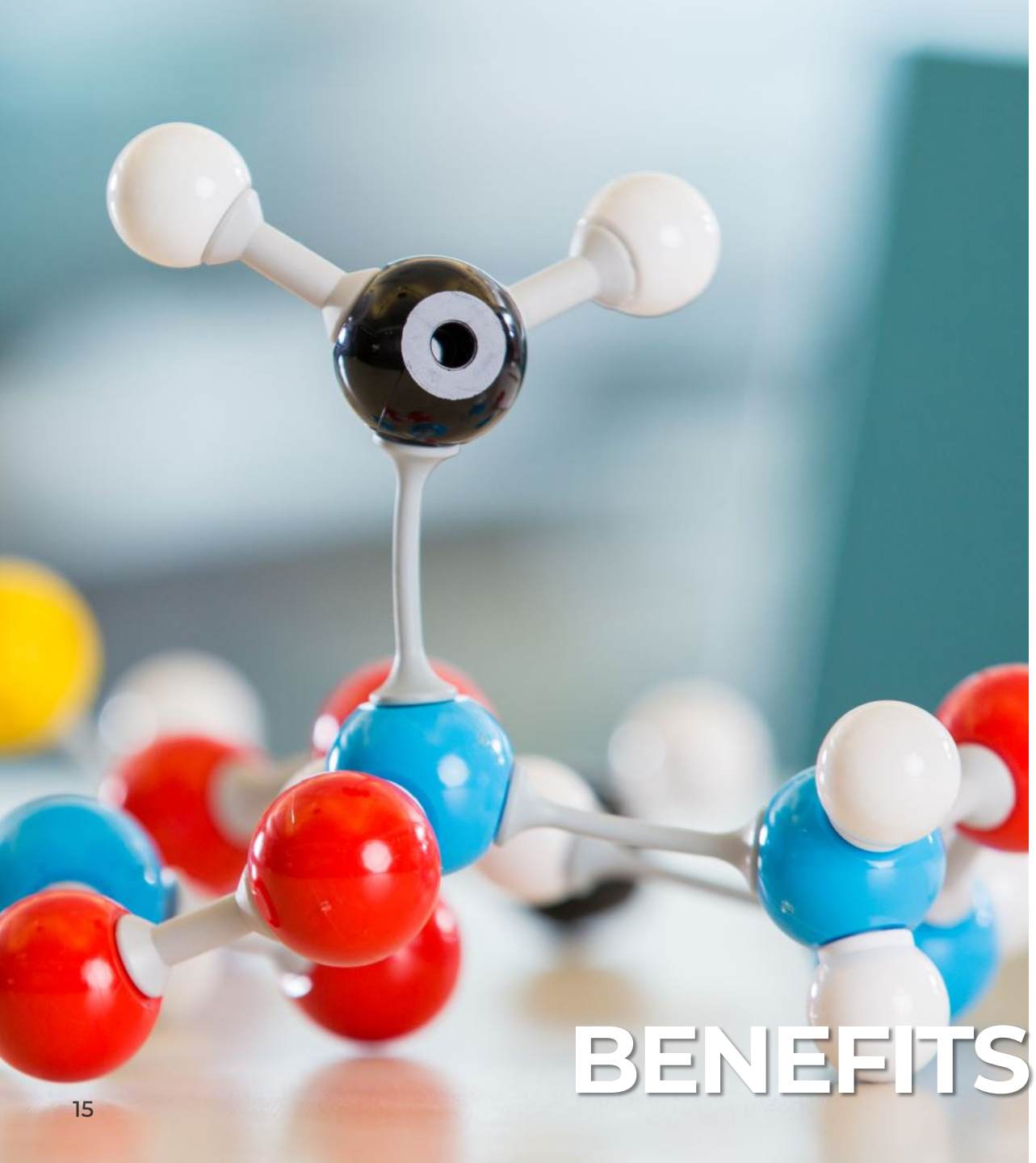

BENEFITS

Nature	Photosynthesis, respiration, and decay are all chemical reactions that are important in the ecosystem
Farming	Chemical reactions are used to produce fertilisers to increase the amount of food that farmers can grow
Hygiene	Shampoos contain alkalis which remove dirt and grease; conditions contain mild acids to neutralise the alkalis and prevent rough hair
Healthcare	Our stomach produces hydrochloric acid to help in the digestion of food. Antacids contain weak alkalis to neutralise extra acid in stomach (during indigestion)
Manufacturing	Many raw materials are changed into useful products. Eg. compounds in crude oil are used to make plastics, paints, and cosmetics.

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HARMFUL REACTIONS

Burning

Air pollutants are produced when fuels in motor vehicles, factories, and power stations are burnt.

Air pollutants are harmful substances that make the air look and smell bad. Polluted air is harmful to our health and to the environment.

Common pollutants

- Gases: carbon monoxide, sulfur dioxide, nitrogen dioxide
- Solid particles: ash, dust, soot

Effects of air pollutants

- Can cause lung diseases (eg. Lung cancer)
- Carbon monoxide is very poisonous when inhaled
- Sulfur dioxide and nitrogen dioxide hurt the eyes, make breathing difficult, and can cause lung diseases

Rusting

When iron is exposed to the atmosphere, it combines with oxygen to form iron oxide, which is rust.

Rust is a weak substance, and objects that are rusted can no longer be used.

Decay of food

Food has micro-organisms growing on them. These cause chemical reactions that can make food go bad and give it a bad taste or smell (decay). Eating decayed food can cause food poisoning.

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