

Inside the Crystal World

The Crystal Science Handbook for Budding Scientists



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PREFACE

Hi budding scientists,

Welcome. Have you ever noticed the tiny sparkly sugar what if we tell you that those shiny sugar are not just any cubes, they are actually crystals. Crystals are all around us and you are about to uncover their magical world. This book will take you on an interesting ride into the world of crystals through simplified concepts, fun activities, cool experiments. You will learn what crystals are, how they grow, what is so special about them, and why to study them.

This book is your personal diary to explore crystal science by drawing, finding, making, solving and even creating your own crystal. This book is to ignite your curiosity and help you discover the untold stories of crystals. By the end of this book, you will be thinking all about crystals and seeing the crystal science in a whole new way.

So, grab your pen, put on your detective hat and get ready to learn, build, and shine your way to crystal science the world of crystals is waiting for you.

Let's get started!!!!

What to expect:

- Easy-to-understand explanations and simplified concepts.
- Fun facts and trivia
- Hands-on experiments and DIYs
- Games and puzzles
- A certificate of achievement

By the end of this book, you will have an idea of:

- Different types of solids
- Basics of crystal science
- Applications of crystals
- Explore the world through a crystallographer's eyes

MATERIALS NEEDED

For growing crystals

- Sugar, salt to make crystals
- Water (hot and cold) to dissolve the materials to make the solution
- Strings or thread to see how crystals grow on them
- Clean and clear glass/paper cups to grow and observe your crystal
- Spoons to mix solutions
- Food colouring (optional) to make coloured crystals

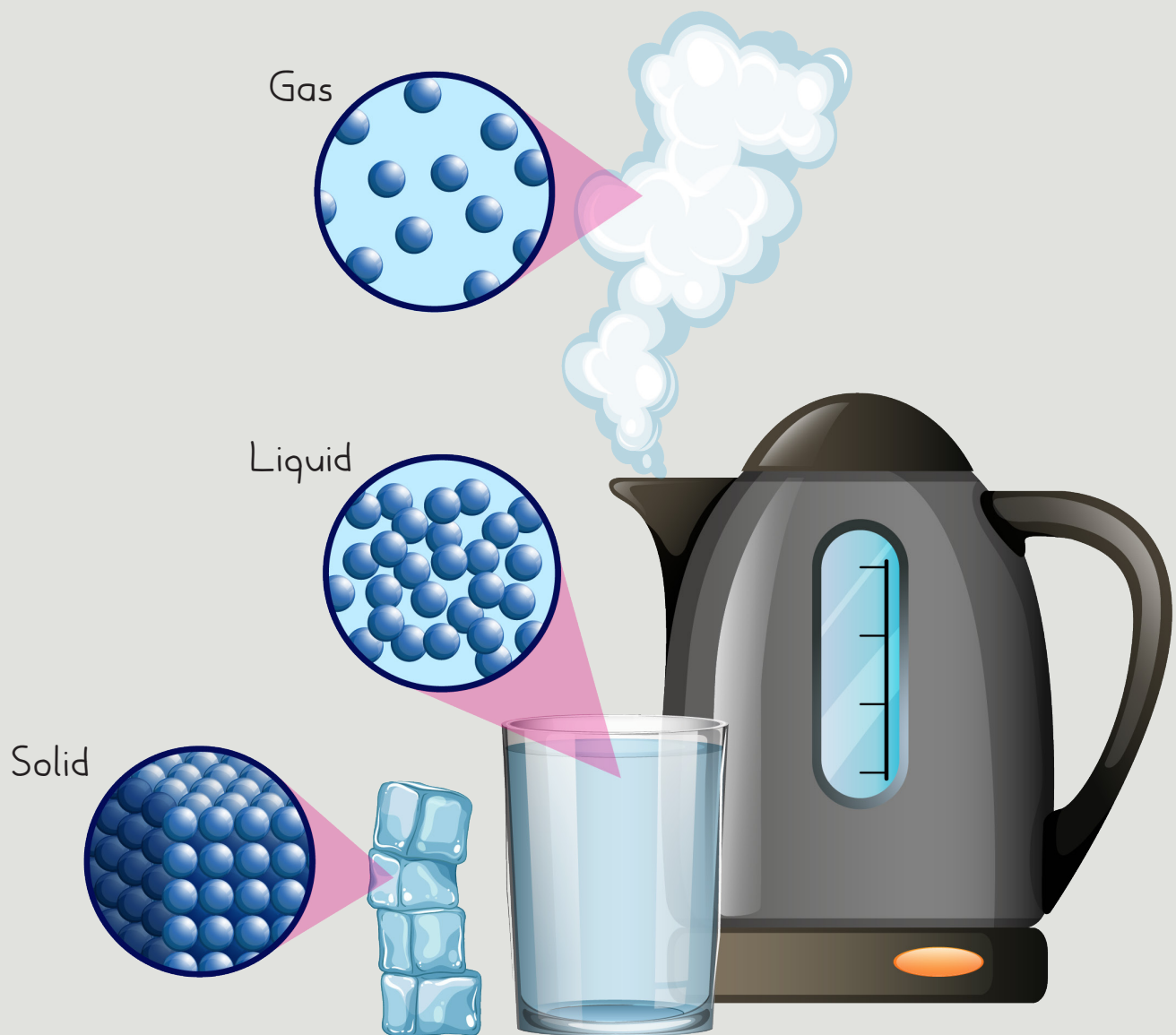
For observing and data collection

- Pen or pencils, paper to write down notes, observations and drawings
- Highlighter or colour pens to draw crystals, shapes, and track changes
- Scissors, glue, ruler for paper models and crafts
- Stacking blocks and colour papers to make crystal patterns and unit cells
- Magnifying glass to look closely at your crystals (optional but fun!!!)

Note for adults: Most of the activities given in this book are simple, safe and designed for children aged 7 to 12. However, for materials like hot water, adult supervision is advised to ensure the safety of the children.

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CHAPTER 1

STATES OF MATTER

What is everything made of?



Look around you, what all can you see?

Can you touch it, can you smell it, can you feel it????

This book, water and the air that we are breathing - all of these are made of **MATTER**.

Matter is anything that takes up space and has weight. Matter can exist in different states.

The Three States of Matter

1. Solid

- A solid has a fixed shape and size.
- It won't change shape unless we force it to.
- The particles in a solid are tightly packed and don't move around much.

Examples: Ice, book

- Metals (solids) are used to build bridges, buildings and cars.

2. Liquid

- A liquid has a fixed volume and takes the shape of the container it is in.
- The particles in a liquid are not as tightly packed as solid.

Examples: Water, coffee

- Water helps plants and trees to grow that keeps us alive.

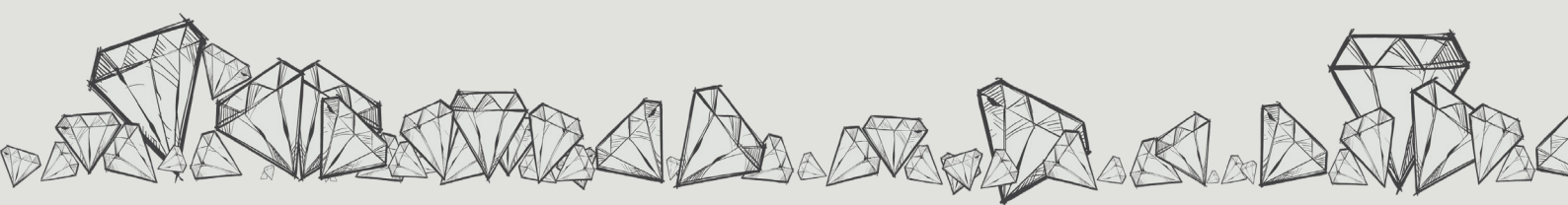
3. Gas

- A gas has no fixed shape or fixed volume.
- It spreads out and fills up any space.
- The particles in a gas are far apart and move quickly.

Examples: Air, steam

- Gases like helium are used to make party balloons that float and fly.

Scientists have discovered other states of matter too, but we will focus on the main three in this book.



ACTIVITY 1: Matter Scavenger Hunt

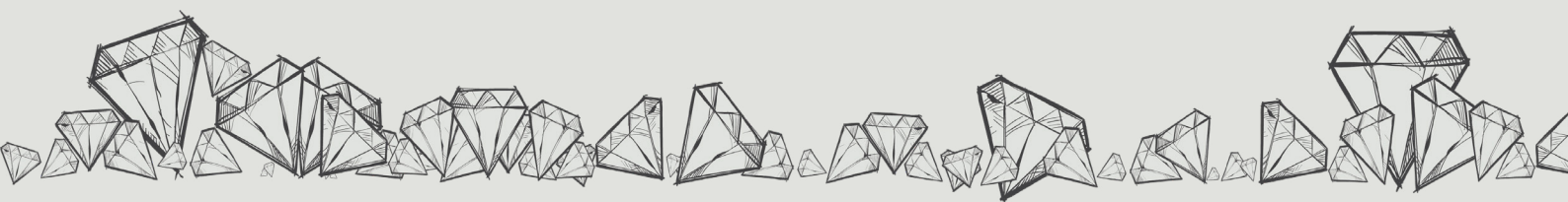
What you will need: Pencil or pen, your detective hat, magnifying glass, your curiosity.

What to do: Look around you.

Try, feel and find

- Solids
- Liquids
- Gases

If you like, draw a picture of them.



CHAPTER 2

**ALL ABOUT
SOLIDS**

The Magic of Solids



Now you know that solids are one of the main states of matter, let's explore the world of solids.

Solids are strong – they keep their shapes. Neither do they flow like liquids, nor they float away like gases. The particles in solids are held together by strong forces.

Types of Solids

Not all solids are the same – solids can be mainly divided into two types:

1. Crystalline Solids

Crystalline solids have their particles arranged in regular repeating pattern.

Examples and real-life uses : Salt, sugar, quartz, paracetamol.

Electronics: Quartz crystals are used in watches.

Medicines: Crystals are used to make medicines.

Constructions: Crystals such as marble and granite are used to make floors.

Food items: Crystals such as salt and sugar add taste to the food that we consume.

2. Amorphous Solids

Amorphous solids doesn't have regular repeating pattern – particles are jumbled and messy.

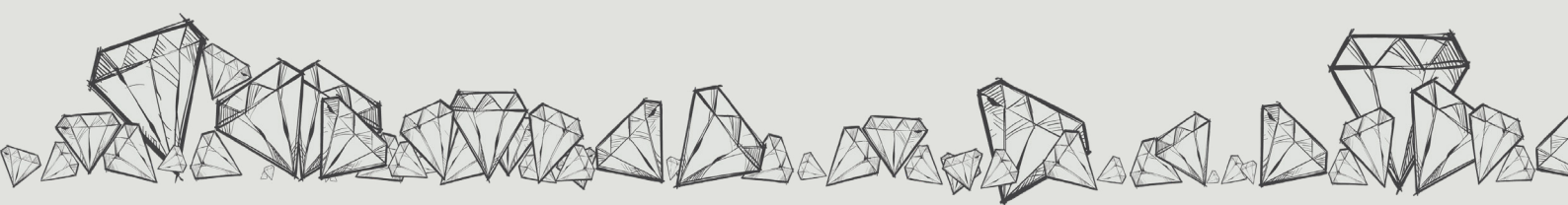
Examples and real-life uses : Glass, rubber, plastic. Glass are used in screens and windows.

Science Word alert!!! Amorphous = without shape (Greek origin).

Fun Facts!

No two snowflakes are exactly alike!!!

Diamonds are crystals – Hardest solids on Earth.



ACTIVITY 2: Solid Sorting

Find some solids around you. Is it shiny? Are they stretchy or smooth?

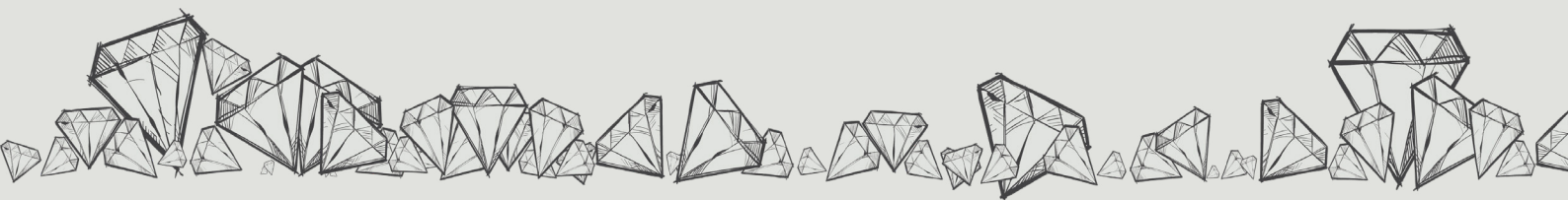
Write down their similarities and what are the differences????

Materials:

Similarities	Differences

Find answers to the following question

- 1. Can something be both crystalline and amorphous?



CHAPTER 3

**ALL ABOUT
CRYSTALS**

The Magic of Crystals



Crystals are all around us. They are everywhere. They aren't just in jewellery and rocks; you will find them in your body, your kitchen, and in many more things.

Fun Facts!

Crystals can form naturally in your freezer, caves, and mountains or be grown at home.

The wings of butterflies have crystal structures that reflect light.

ACTIVITY 3: Crystal detective

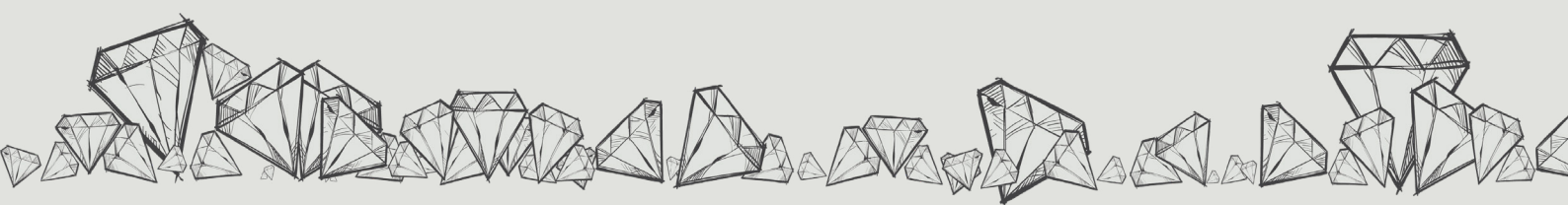
What you will need for this activity

- 1. A few sugar and salt grains from the kitchen.
- 2. A dark background or black paper.
- 3. Magnifying glass or your parents' phone camera (please seek their permission or make it a group activity with your mom and dad.
- 4. Pen or pencil to draw.

What to do

- 1. Place sugar and salt crystals on a black paper.
- 2. Look through the magnifying glass or phone camera.
- 3. Draw the shape of both sugar and salt crystals that you see in the box below.
- 4. How do they look? Are they different? Write down your observat

Sugar crystals	Salt crystals



CHAPTER 4

BUILDING BLOCKS OF CRYSTALS

The Magic of Crystals



Crystals grow in many shapes and sizes. Crystals grow by repeating the blocks in all directions.

Motif: A small group of building block that repeats again and again.

Unit cell: The smallest full block that repeats in all directions to build the full crystal.

ACTIVITY 4: Build your Unit cell

What you will need for this activity

Colour blocks or different shapes (circle, square, rectangle, pentagon, hexagon, etc.) made from paper

Pen or pencil of different colours

What to do

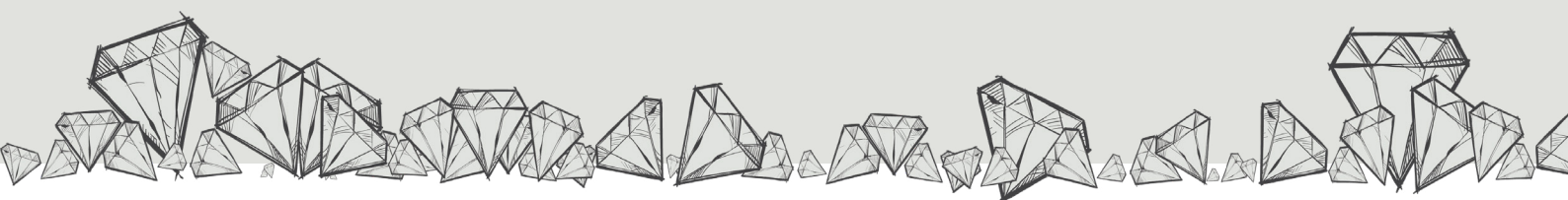
1. Stack the coloured blocks/coloured shapes in repeating patterns in all directions.
2. Please try stacking the blocks/coloured shapes in different patterns and practice how crystals grow.
3. Draw the different patterns that you made in the space provided below.

Pattern 1

Pattern 2

Pattern 3

Pattern 4



CHAPTER 5

CRYSTAL SYSTEMS

The Magic of Crystals



Every crystal in nature comes under one of the seven families; known as the seven crystal systems. Like how your house is different from others.

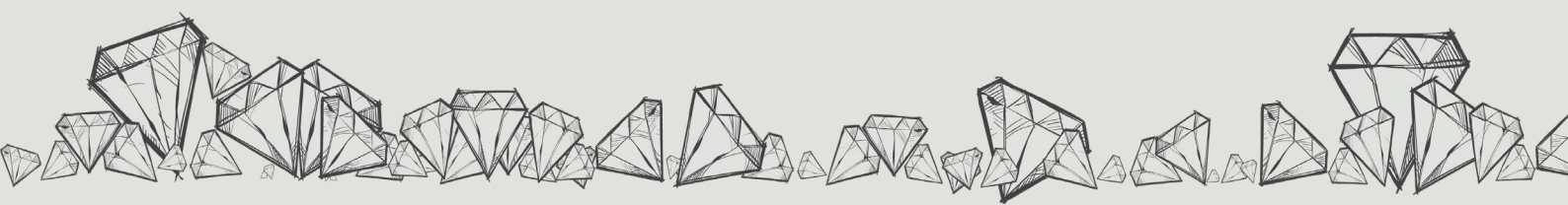
The uniqueness of the crystal lie in their sides and angles. The seven crystal systems are:

1. Cubic: All sides have equal length, and all angles are 90 degrees.
2. Orthorhombic: All sides are different, and all angles are 90 degrees.
3. Tetragonal: Two sides are equal, and one side is different (either longer or shorter), all angles are different.
4. Hexagonal: Has the fewest crystals assigned. e.g: Graphite
5. Trigonal: Also known as rhombohedral system.
6. Monoclinic: All sides are different; two angles are 90 degrees and the third angle is different.
7. Triclinic: All sides and angles are different.

Please try and draw cubic crystal system and repeat them in all directions. Can you arrange them neatly? Can you pick another one and try doing the same. Are they any different? If yes, how?

Why only seven crystal systems?

The building blocks of crystals fit together in space in only in certain ways - without gaps, repeat over and over again in all directions in space. If you try to make more, the blocks won't repeat properly. Imagine the floor with circular tiles. So, nature chose seven perfect ways to form the crystals.



ACTIVITY 5: Crystal Shape Scientist

What you will need

- Pen or pencil of different colours
- Ruler

If you could invent a new crystal system, what shape would it be?

Draw the shape of your crystal below and make the crystal by repeating that shape in all directions. Does it have gaps? Is it forming a repeating pattern?

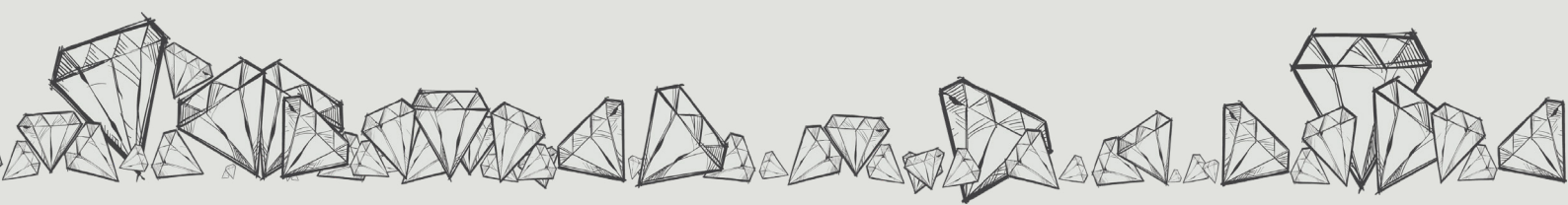
Name of your crystal: _____

Sides: _____

Angles: _____

What does it do - medicine, food, or something else?

How is your crystal different from the seven crystal systems?



CHAPTER 6

CRYSTALLISATION AND CRYSTALLOGRAPHY

The Magic of Crystals



What is crystallisation?

Crystallisation is the process crystal formation from a liquid or gas or melt.

Example: Sugar solution evaporates and sugar crystals form.

What is crystallography?

Crystallography is the science of learning about the crystals – how they are formed, what are they made up of, and the scientists do this by using special tools to look deep inside the tiny crystals.

ACTIVITY 6: Grow some crystals

What you will need

- A few sugar crystals from kitchen
- Cold water and hot water (please be careful)
- Spoon
- Plastic cup, jar or container
- A string or thread

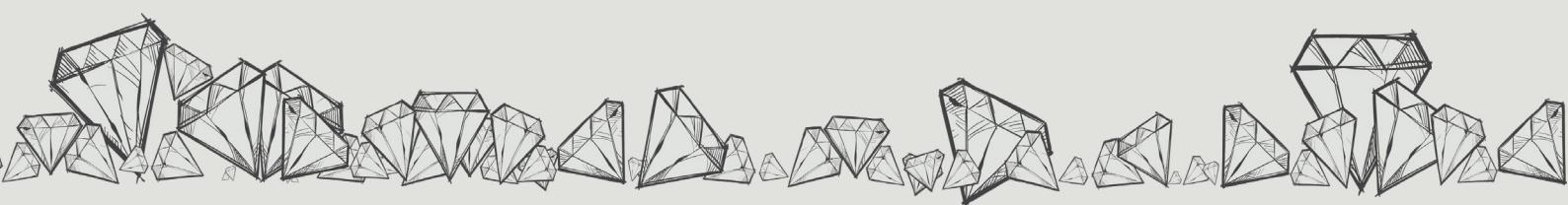
What to do

1. Take a plastic container and add some sugar into it.
2. Add some cold water and mix it until all the sugar has completely dissolved.
3. Repeat steps 1 with hot water.
4. Store both the plastic containers in a place where no one disturbs.
5. Wait for the crystals to grow.

Fun ideas

1. Try adding food colours to make colourful crystals.
2. Try tying a string or thread to a pencil and dip the string.
3. Try using salt and baking soda instead of sugar.

Check: What are the differences you can observe when the crystals are formed from salt, sugar, or baking soda?

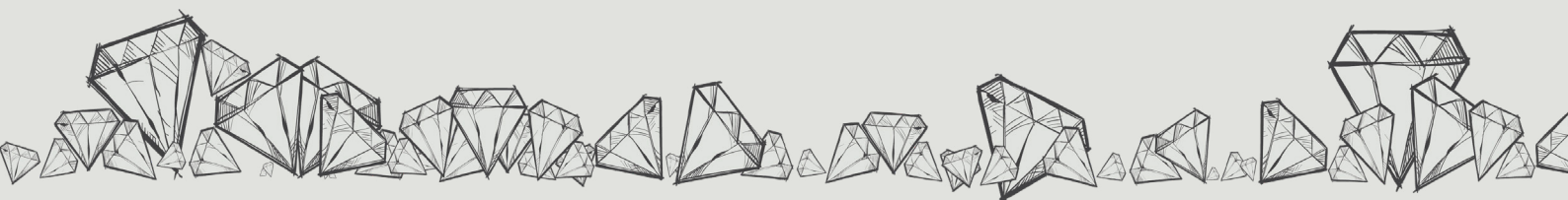


ACTIVITY 7: Crystal Experiment Log

Start a daily or weekly log

- Check your crystal's growth - the shape, size, colour, and everything that you see.
- Do you see a difference between crystals grown from cold water and that of hot water? If yes, write them down in the crystal experiment log below:

Date	Crystals grown from Cold water	Crystals grown from Hot water



CHAPTER 7

CRYSTALS IN EVERYDAY

The Magic of Crystals



Crystals in your Home

Clocks and watches have a tiny crystal called quartz which help them to keep perfect time.

Salt, sugar, baking soda, and chocolates can form crystals.

Crystals in Living things

Did you know the bones and teeth consist of small crystals? These crystals make them strong!!!!!!

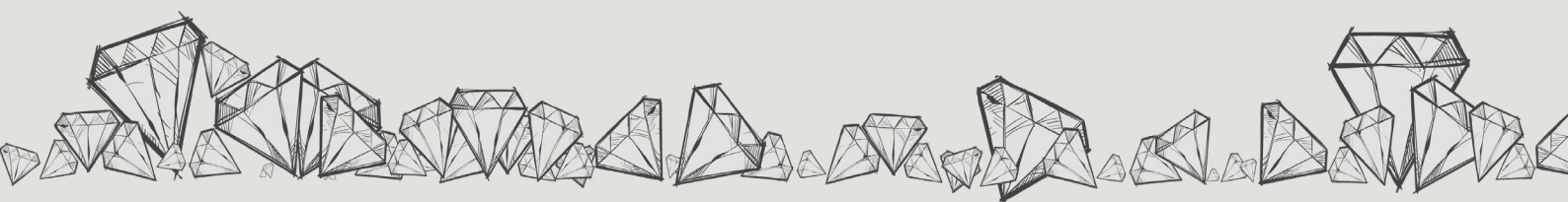
Why do Crystals matter?

Crystals help us to make:

1. Medicines
2. Electricity
3. Computers, phones, and tablets

People who study crystals are called crystallographers or material scientists. The crystallographers discover new crystals, make new crystals with better properties, understand how they grow, and help all of us in contributing to a better planet.

So, the next time you see a crystal, look closely at the small details, ask questions, and be curious.



CERTIFICATE OF ACHIEVEMENT

Huge congratulations!!!!

You have completed your journey into the amazing world of crystals and the science behind it.

This certificate is awarded to _____ for
exploring the world of crystals and showing curiosity, creativity, and enthusiasm.

Date & Sign



THANK YOU SO MUCH!!!!!!

A big thank you to all the vibrant budding scientists, teachers, and parents who delved into the world of crystals with us. Keep asking questions, keep exploring, keep shining, and always remember the world's next discoveries might one day come from YOU.

Thanks to the CCDC for funding, researchers, designers, editors, and science supporters who helped make this book filled with fun and learning!!!!



ACTIVITY SHEETS

