

Amazing Water

Vol 1 Lesson 1b Chemistry



In Review

Water on Earth
Water in Heaven

Revelation 22:1 KJV

And He showed me a pure river of water of life, clear as crystal, proceeding out of the throne of God and of the Lamb.

Psalms 104:3

He lays the beams of his chambers on the waters, he makes the clouds His chariot, walking on the wings of the wind.

2 Peter 3:6

...the earth also which was formed out of water and by means of the water...

So many Goldilock's Principles at Work

God created earth to be inhabited…
Isaiah 45:18 with Just Right Conditions:

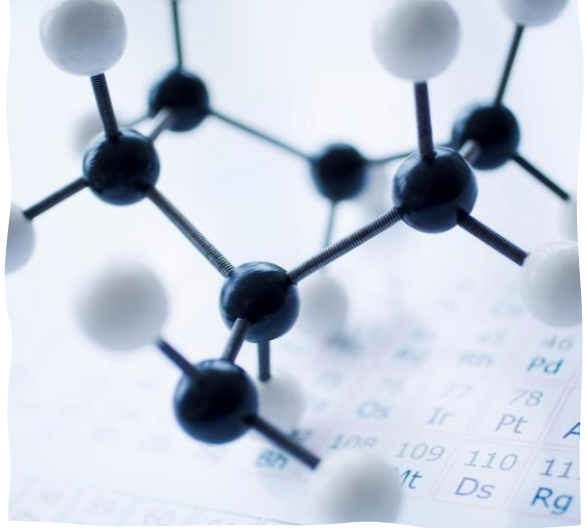
- On Earth in the Habitable Zone to both cool and warm
- Solar Radiation to drive the Water Cycle
- Polarity to get vitamins and minerals throughout our bodies, but not overload
- Just Right Abundance on Earth
- Just Right Substance to clean, carry, hold, move, and hydrate



What can we learn from our Experiment



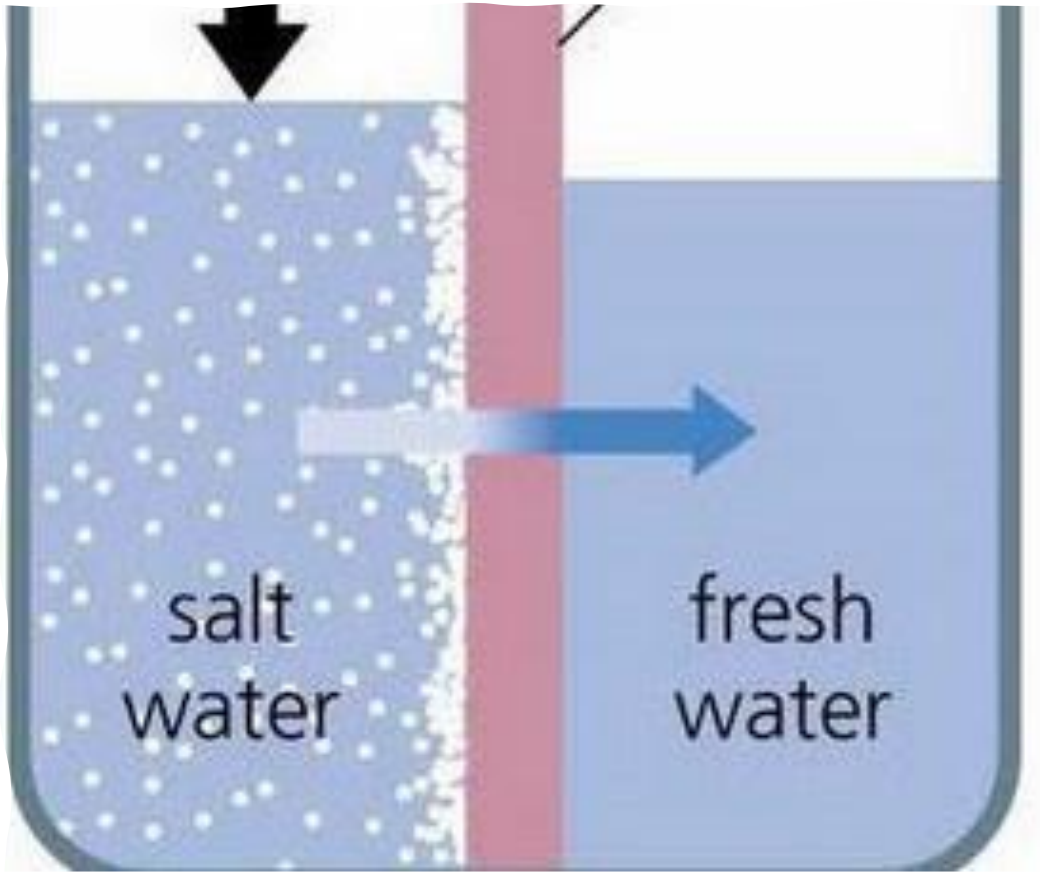
Experiment – Which are the **Just Right Potatoes**



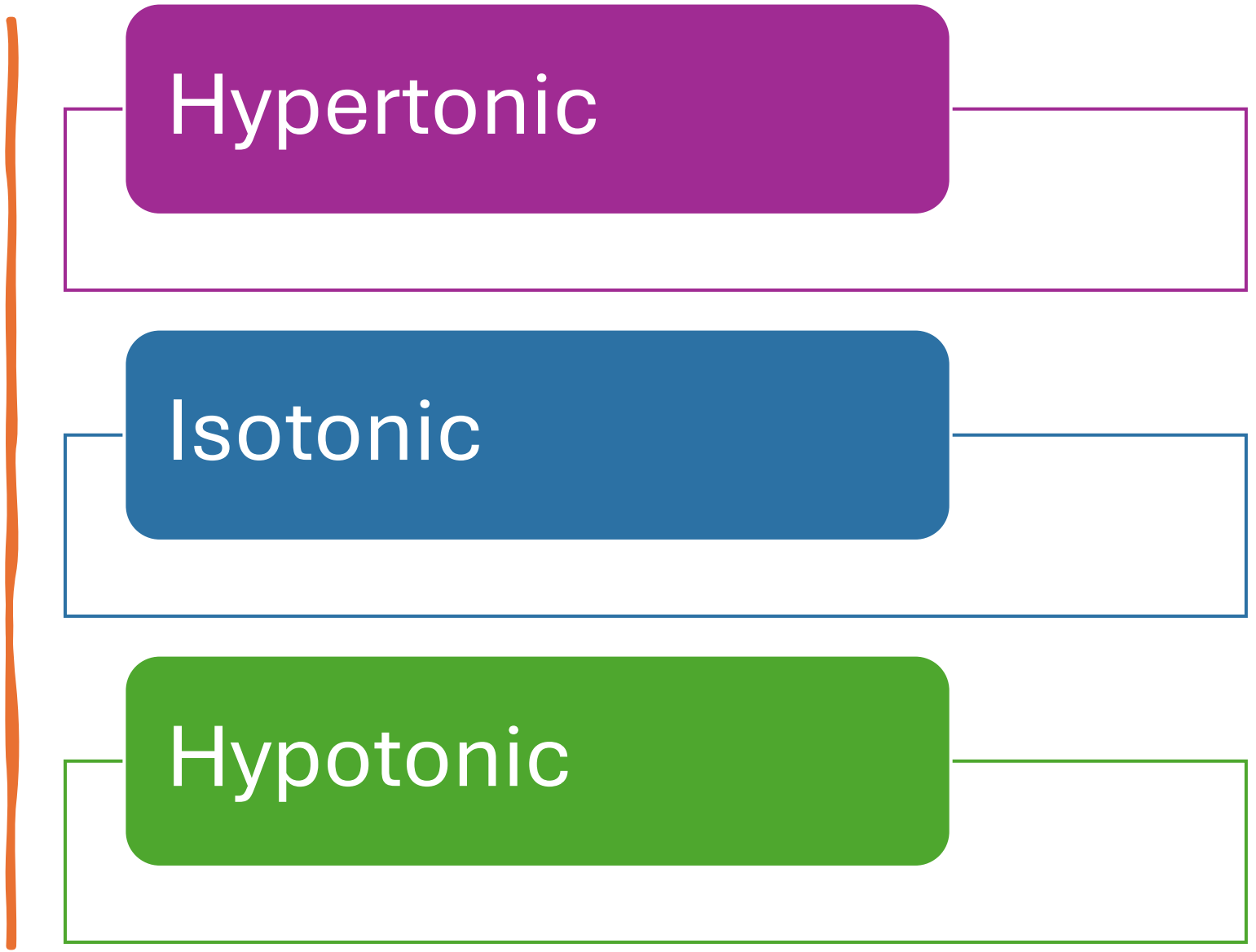


- Saltwater Solution
- Distilled Water
- No water (or mild saline)

Hypo/Hyper/Iso



Just right water is necessary for life



Hypotonic – cell swells

Isotonic – cell stays the same

Hypertonic – cell shrinks



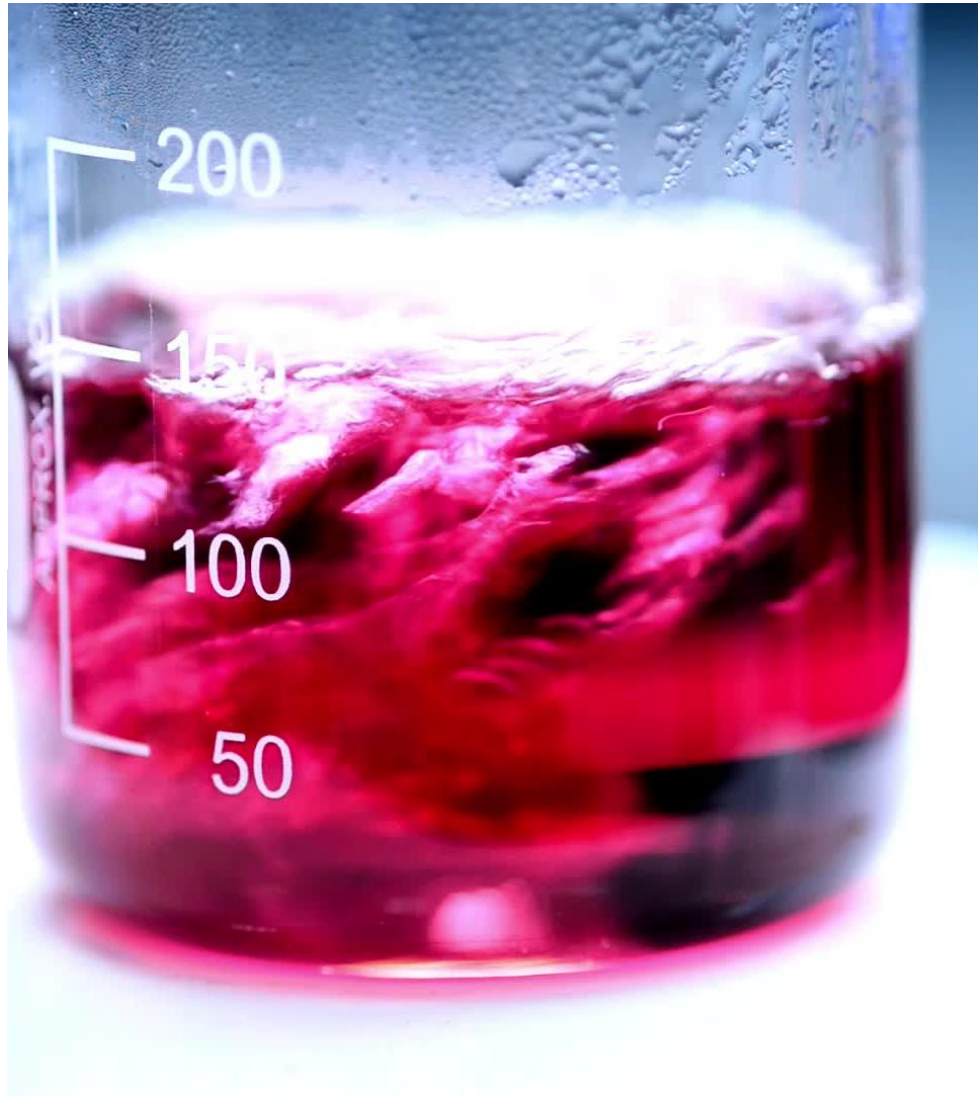


Too much salt makes dehydrates

Bursting Blood Vessels

- If water wasn’t a good solvent, it wouldn’t be good for us
- And if water were too pure, too hypotonic, it can cause lysis (bursting).
- When adding water in an IV, saline solution is necessary.





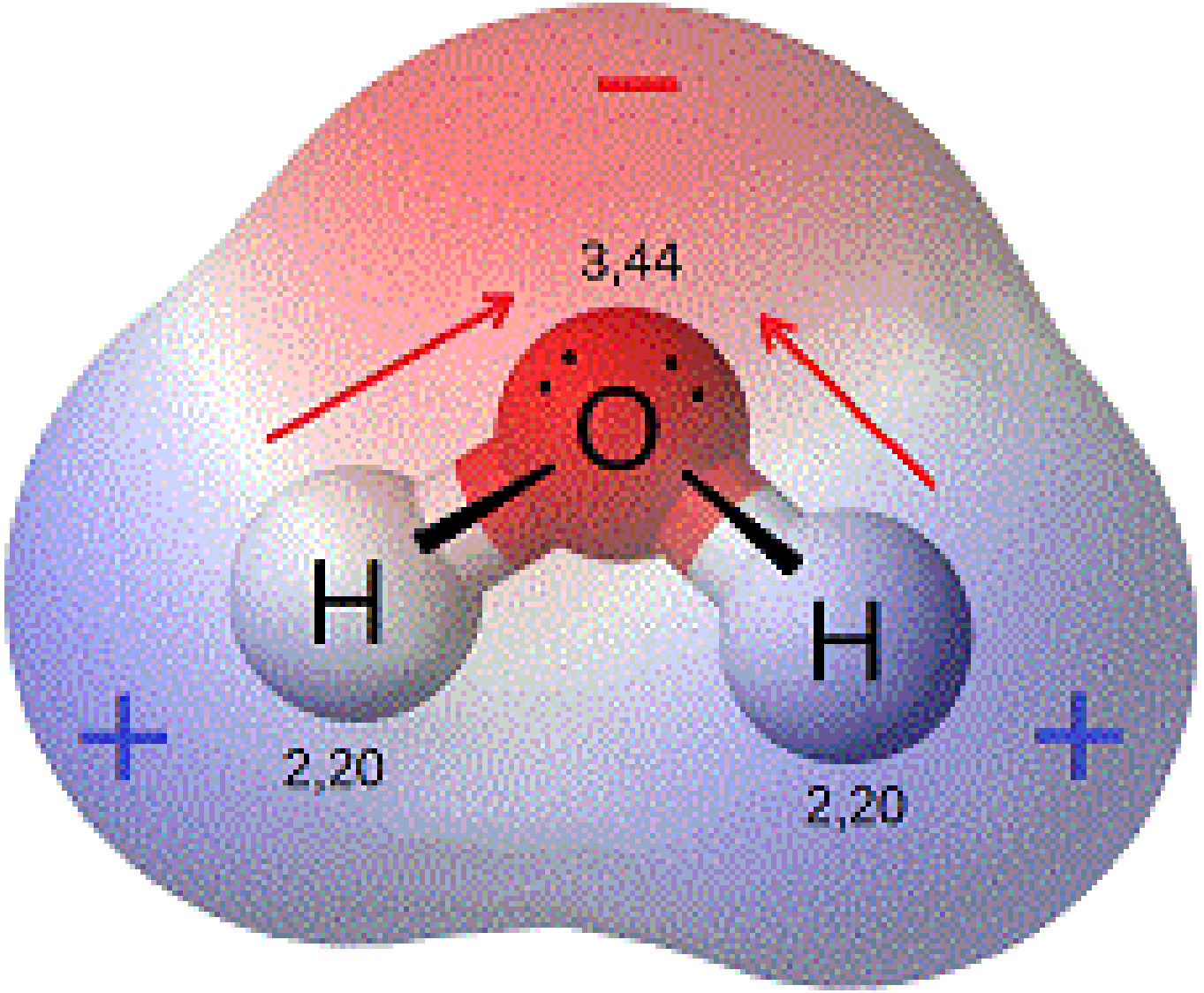
Universal Solvent

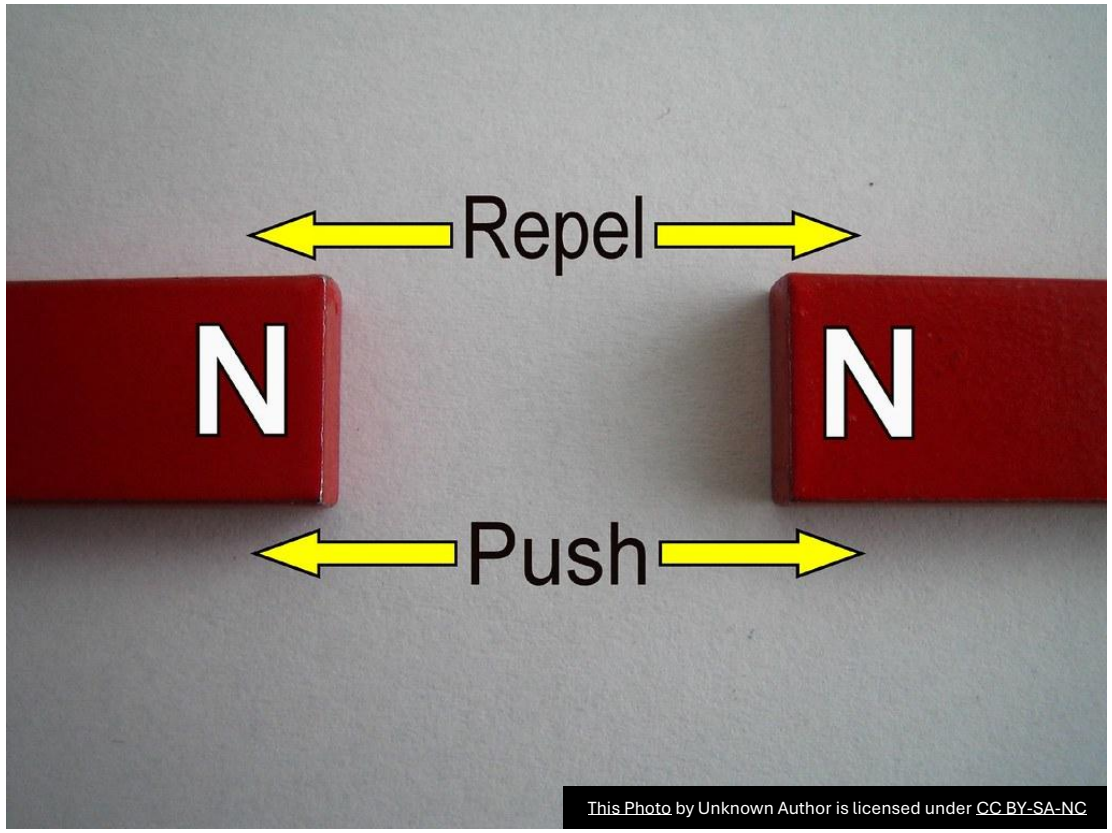
- Water dissolves more substances than any other **solvent**
- Makes ionic solutions of hundreds of **solutes**
- Solutes break down into individual atoms, ions, or molecules as they dissolve



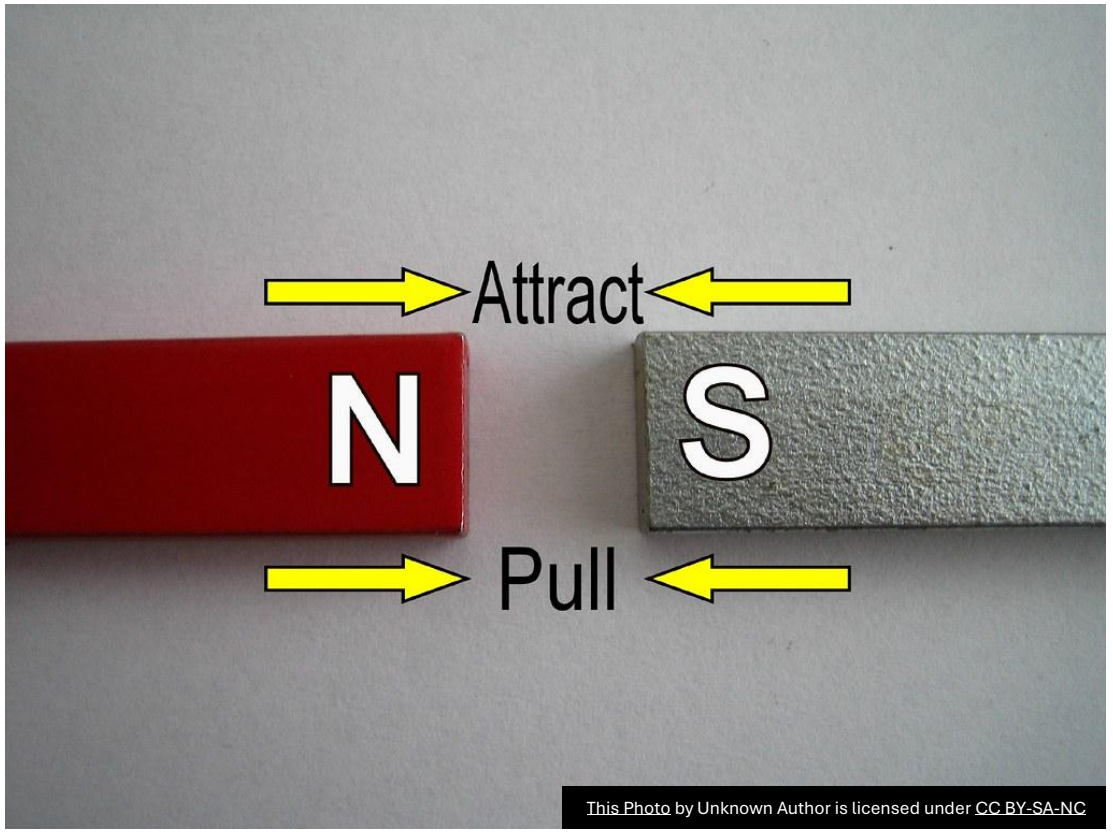
Polarity

- Pulling electrons closer to the Oxygen end = stronger negative pull
- Losing electrons on the Hydrogen end = stronger positive pull
- Strong covalent bond rather than ionic bond which dissolves more easily in water





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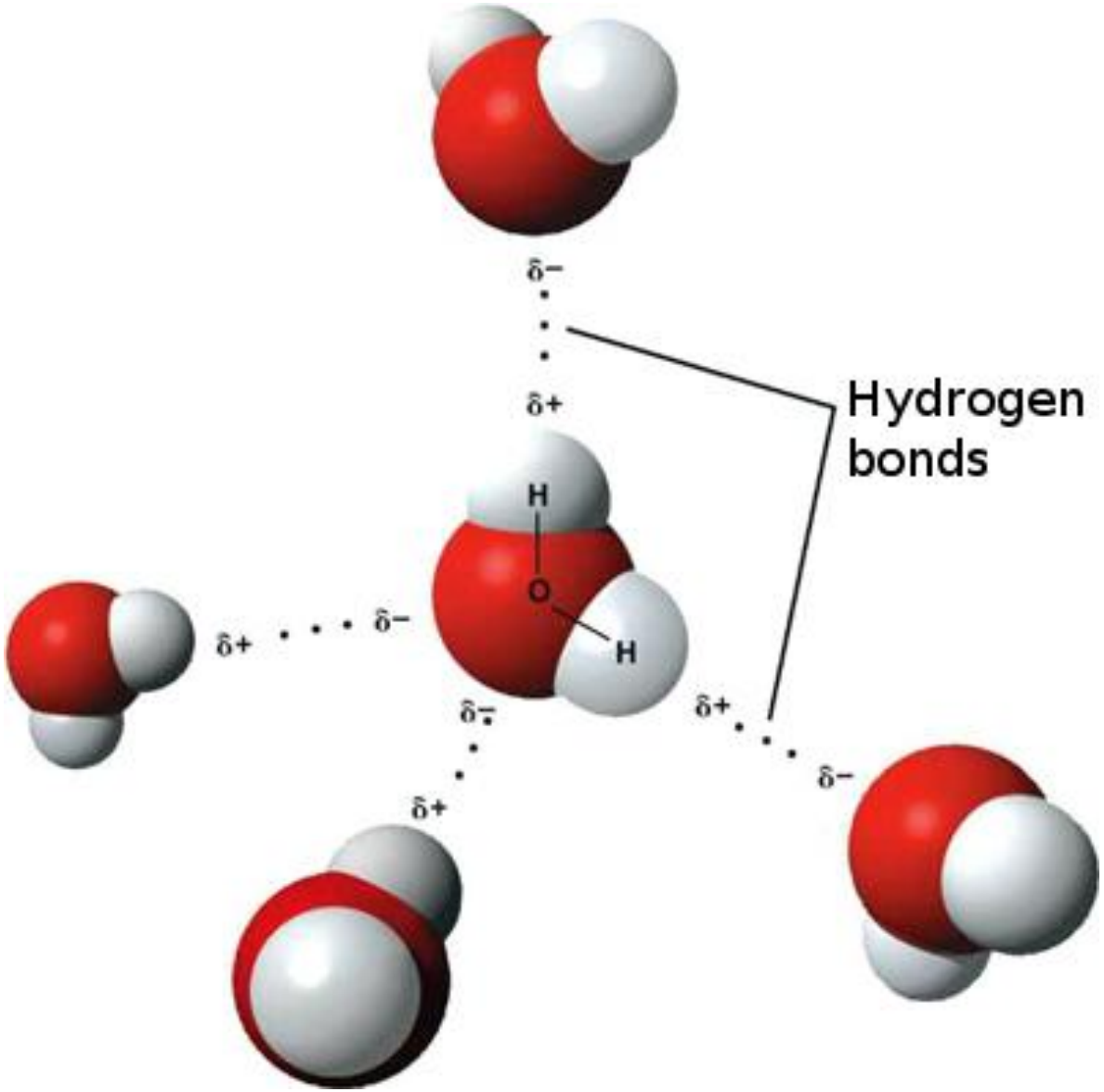


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Water works like Magnets

- Amazing solvent for cleaning products (bases)
- Water's strong surface tension
- Cohesion and Adhesion properties

Hydrogen Bonds in Water are different





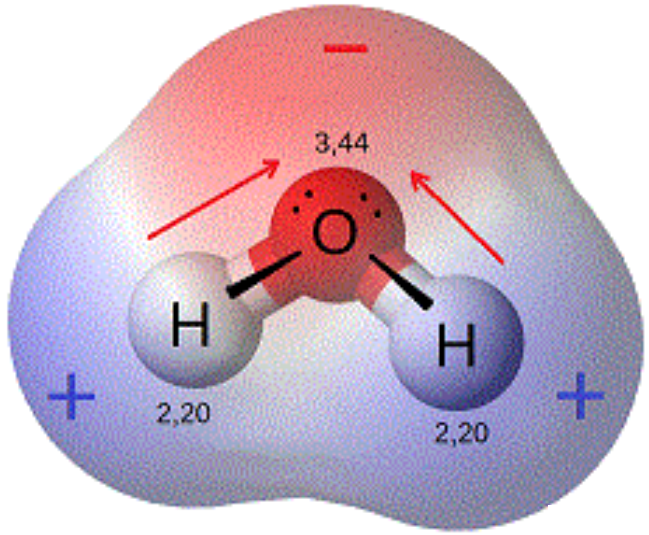
Chemistry Review

Water

- Water is Matter
- Water is a Compound
  - 2 different elements
  - Bonded together
- A Water Molecule is
  - Water’s smallest unit
  - 2 or more atoms
  - Bonded together
  - Pure substance

The smallest unit of a Compound is a **Molecule**

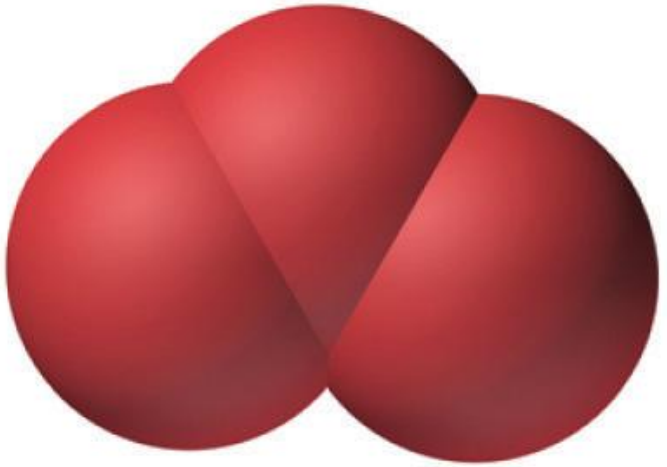
- A molecule is a smallest basic unit of a chemical substance
- Two or more atoms (can be the same element such as O_2 or N_2)
- An Ozone molecule is simply O + O + O = O_3



Water H_2O

Water is both a compound and a molecule

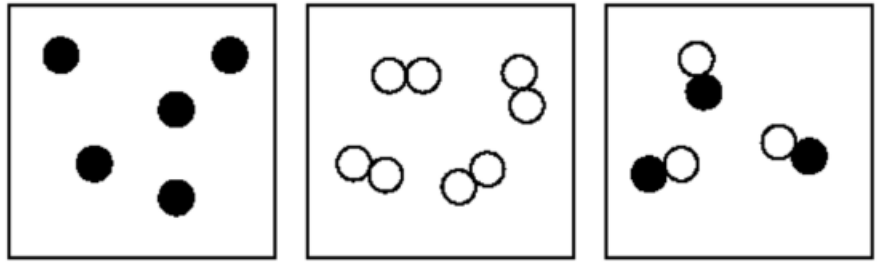
Ozone is a molecule, but not a compound



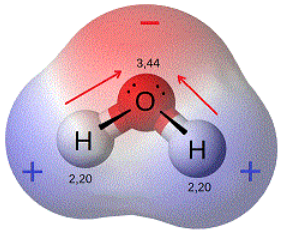
Ozone, O_3

WATER IS MATTER MADE OF ATOMS

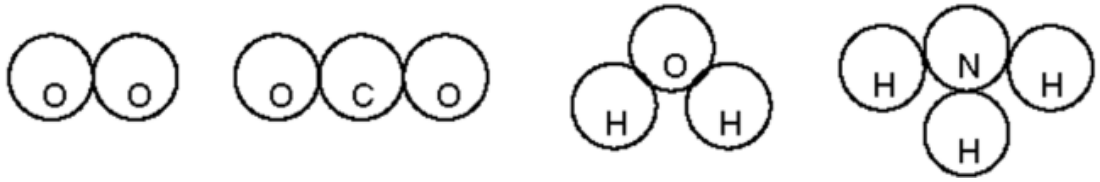
Atoms, Molecules, and Compounds

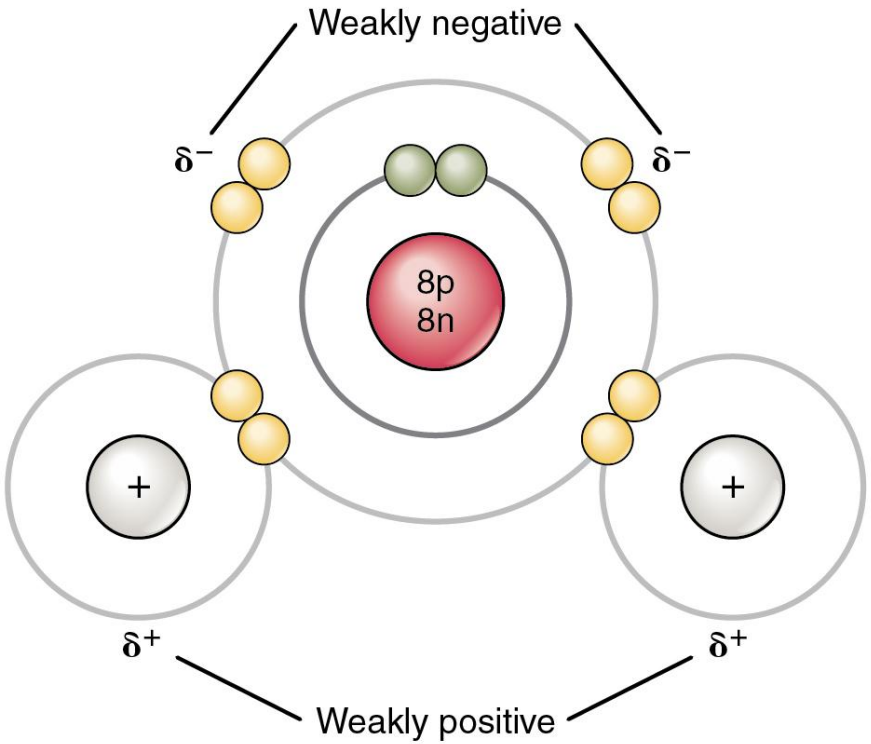


Circles represent an elemental atom.

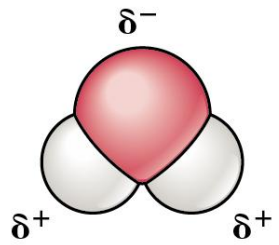


Formulas for Molecules & Compounds

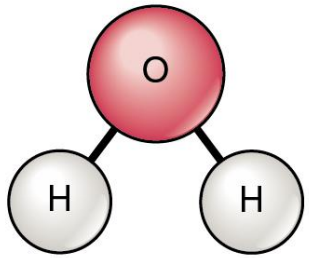




(a) Planetary model of a water molecule



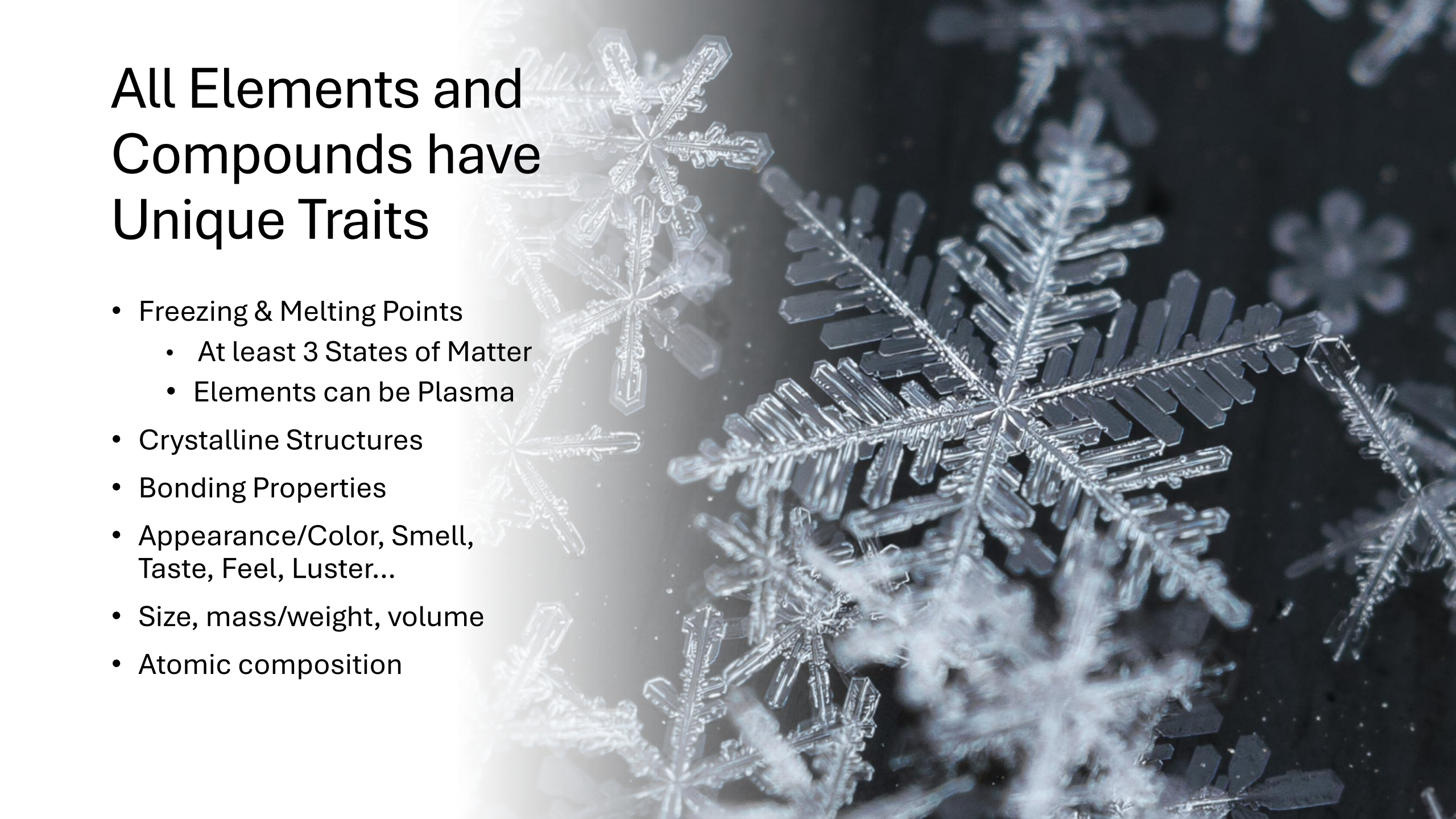
(b) Three-dimensional model of a water molecule



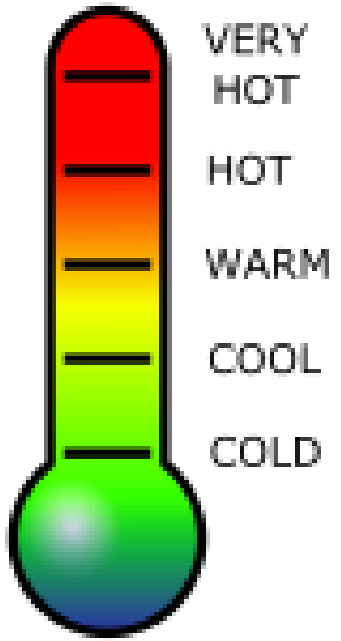
(c) Structural formula for water molecule

All Elements and Compounds have Unique Traits

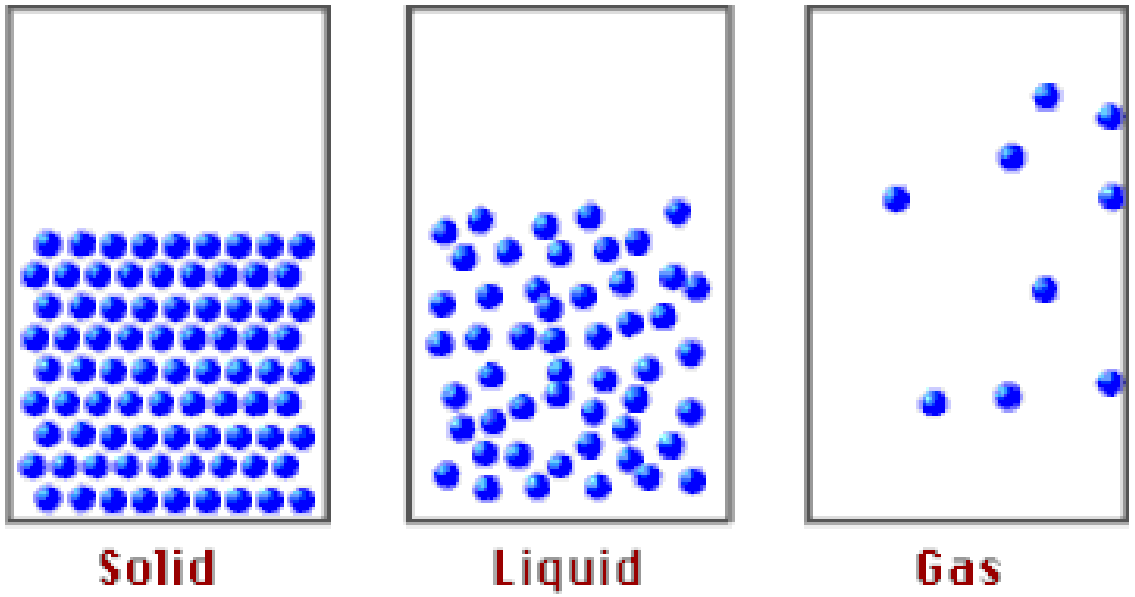
- Freezing & Melting Points
  - At least 3 States of Matter
  - Elements can be Plasma
- Crystalline Structures
- Bonding Properties
- Appearance/Color, Smell, Taste, Feel, Luster…
- Size, mass/weight, volume
- Atomic composition



States of Matter – Are Driven by Temperature



- Solid
- Liquid
- Gas
- Plasma



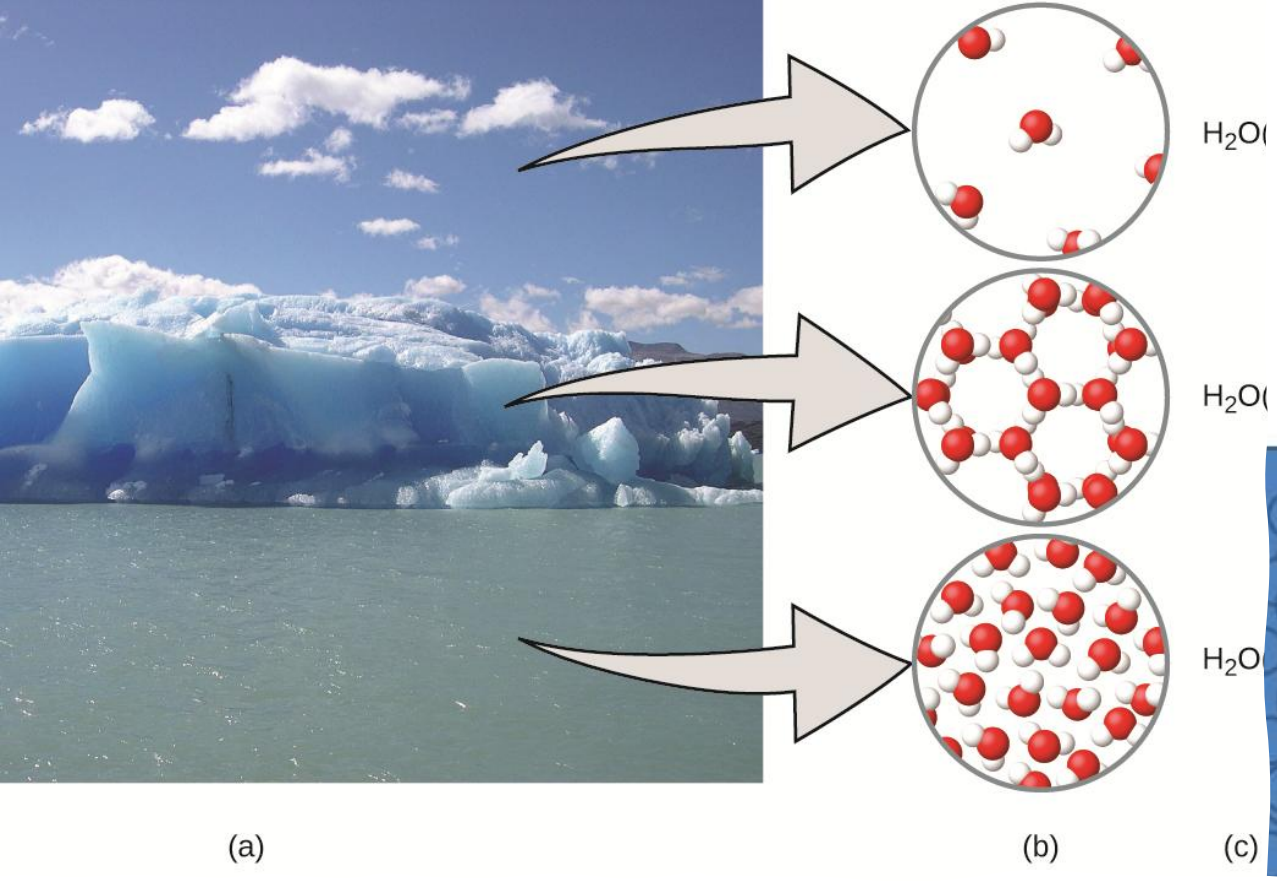
Water Temps at Normal Pressure

- **Water Ice Solids**
- **Liquid**
- **Gas**

Below 0° C or 32° F
Above 0° C or 32° F/Below 100° C or 212° F
Above 100° C or 212° F

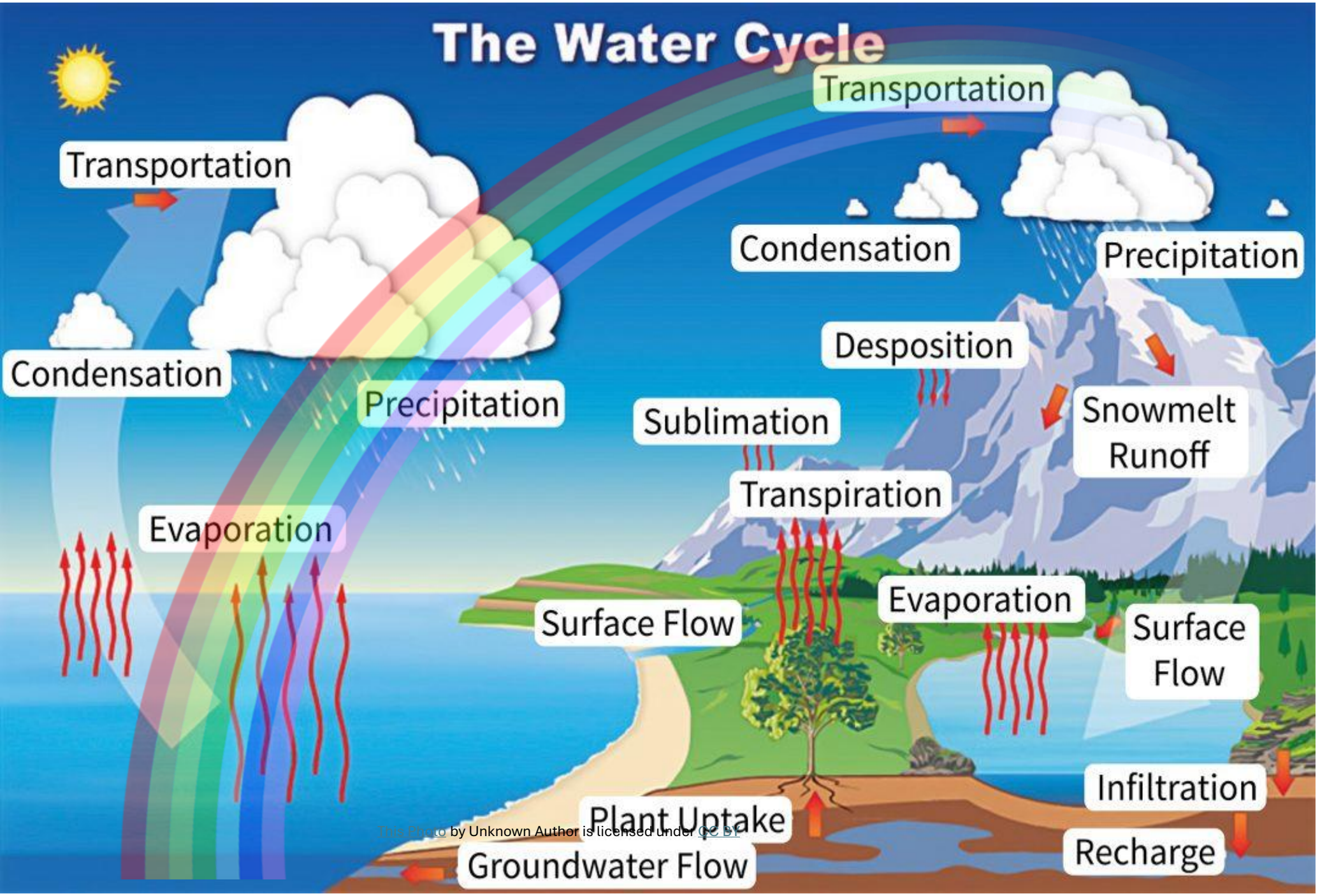
Hydrogen and Oxygen can exist as Plasma, but Water cannot.

***While boiling water creates water vapor (gas state), the photoelectric effect creates water vapor at much lower air temperatures**



Phases H_2O Equalize on Earth Help Maintain Climate

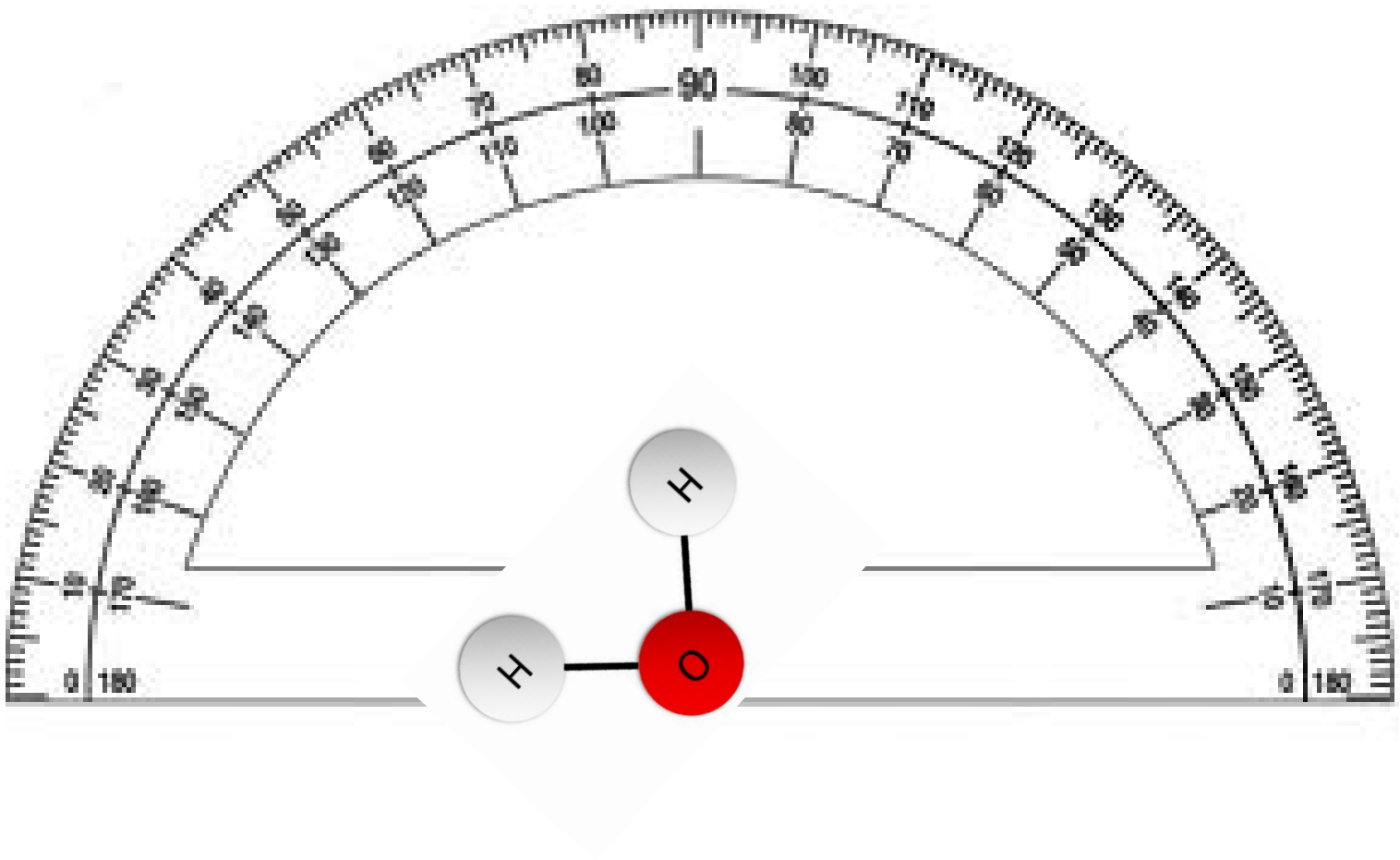
- Vaporization by Evaporation (photoelectric)
- Condensation (vapor to liquid)
- Freezing (liquid to solid)
- Melting (solid to liquid)

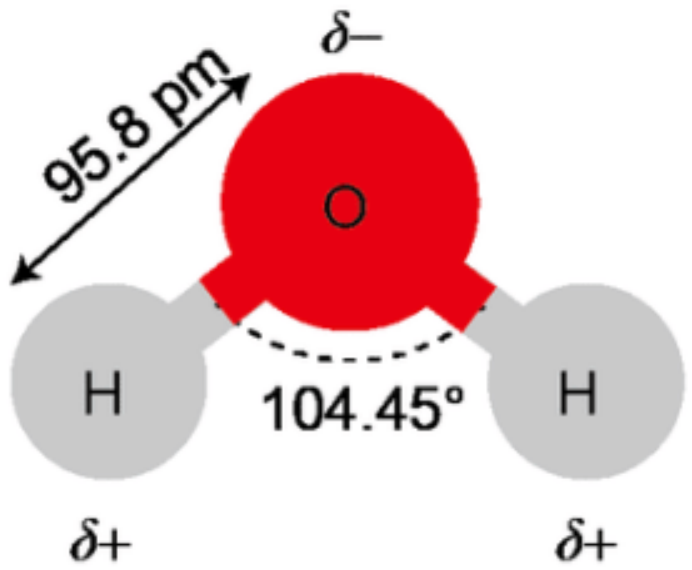


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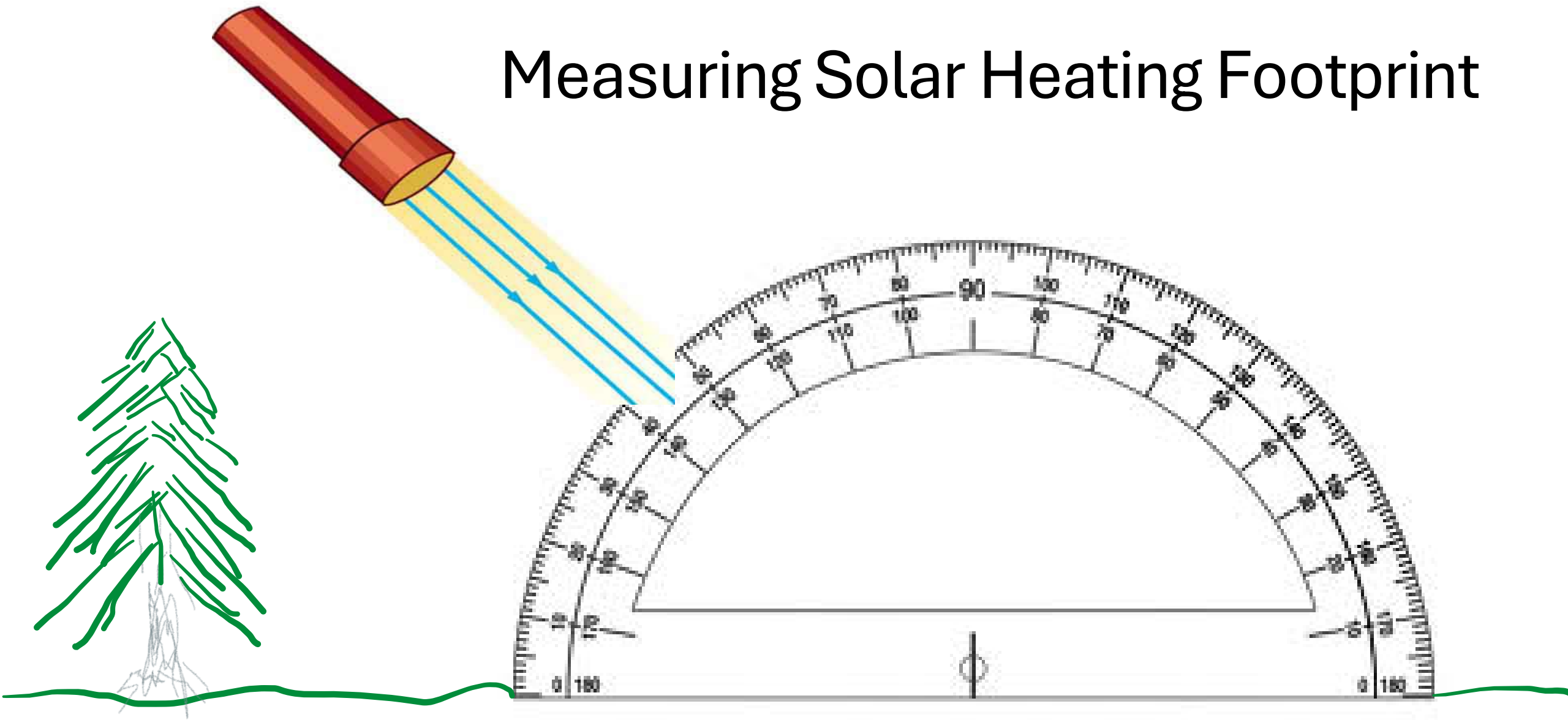
More amazing things about water!!!

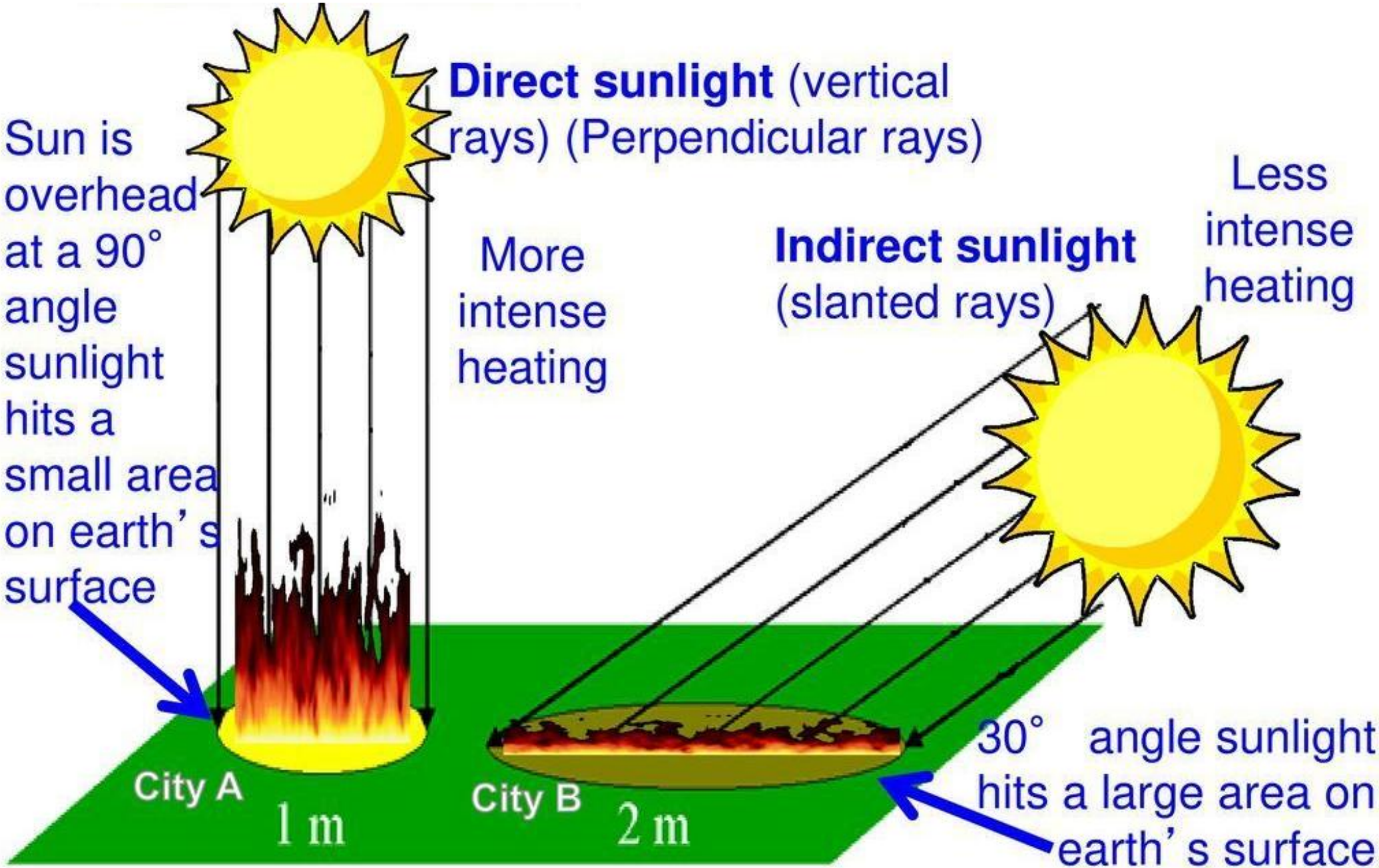
Revisiting Angles

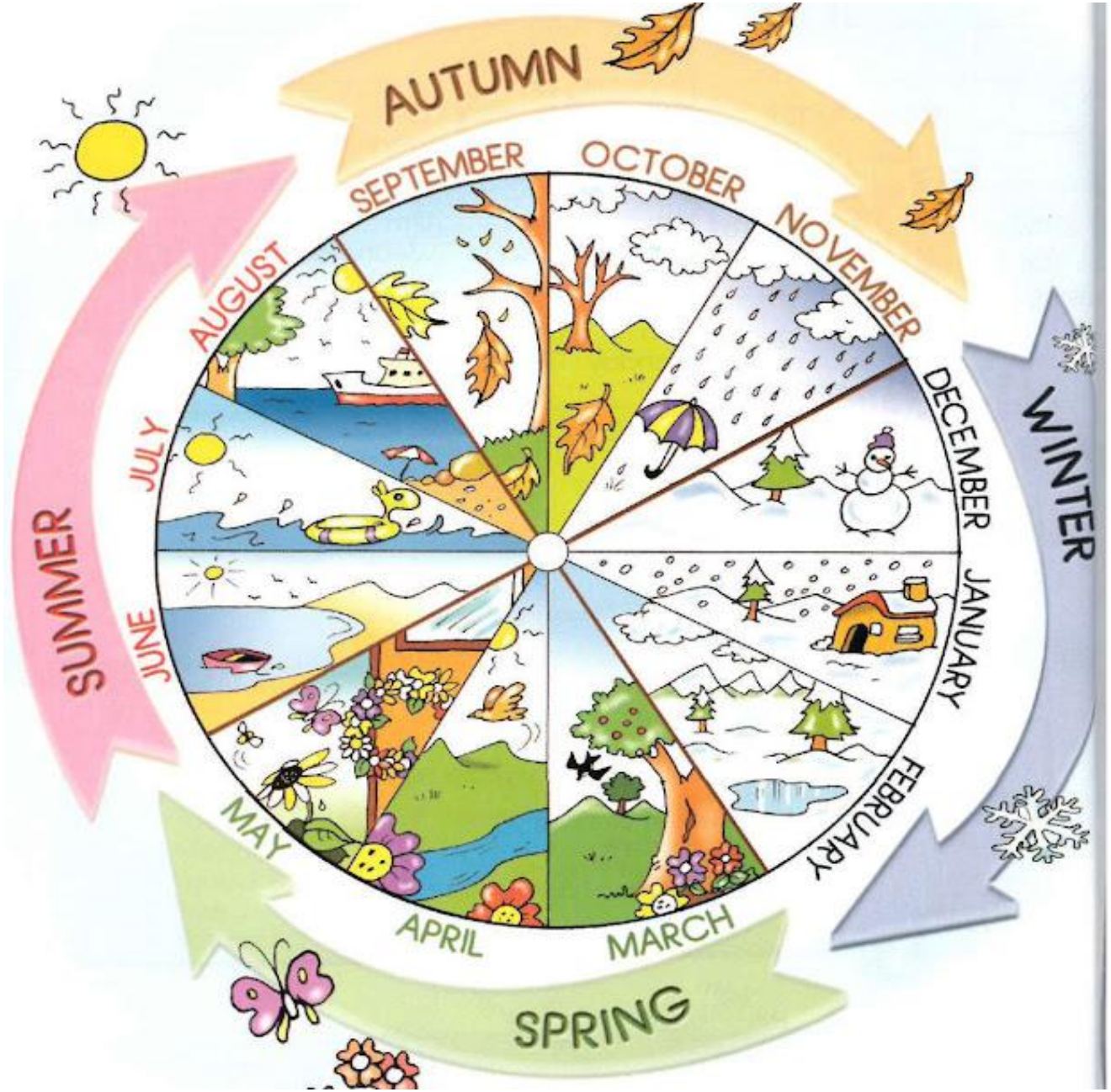




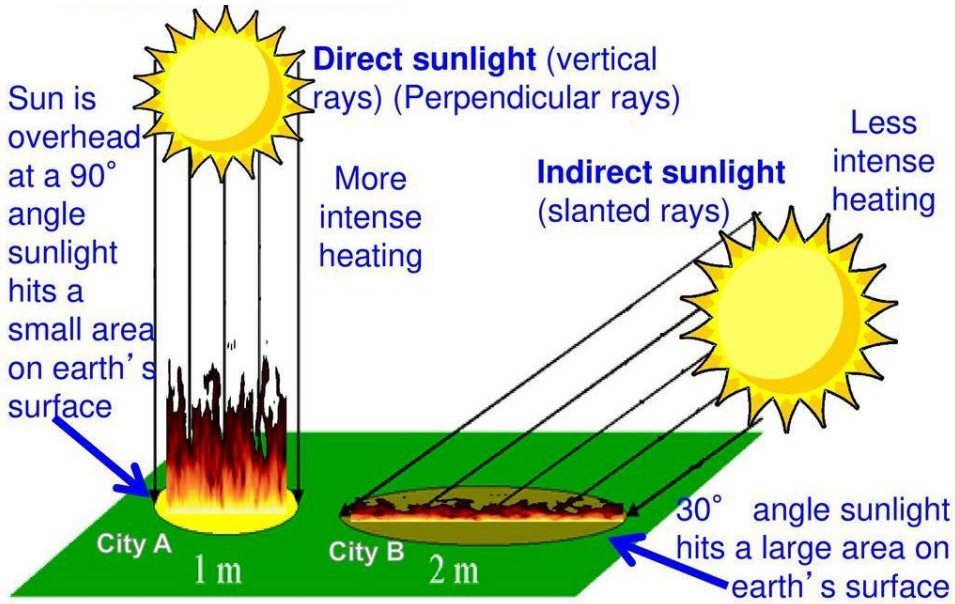
Measuring Solar Heating Footprint




Direct sunlight (vertical rays) (Perpendicular rays)
Sun is overhead at a 90° angle sunlight hits a small area on earth's surface
More intense heating
Indirect sunlight (slanted rays)
Less intense heating
City A
1 m
City B
2 m
30° angle sunlight hits a large area on earth's surface

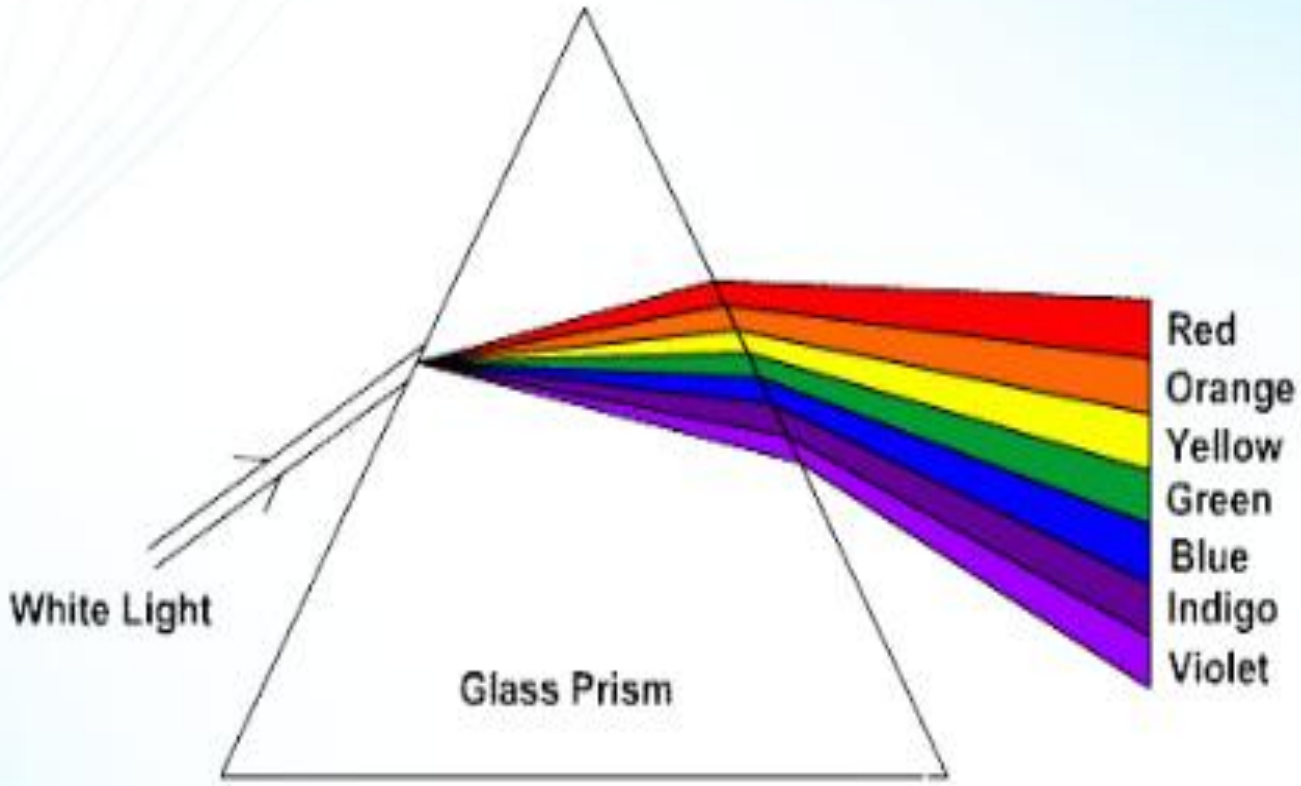


Winter, Spring, Summer, and Fall

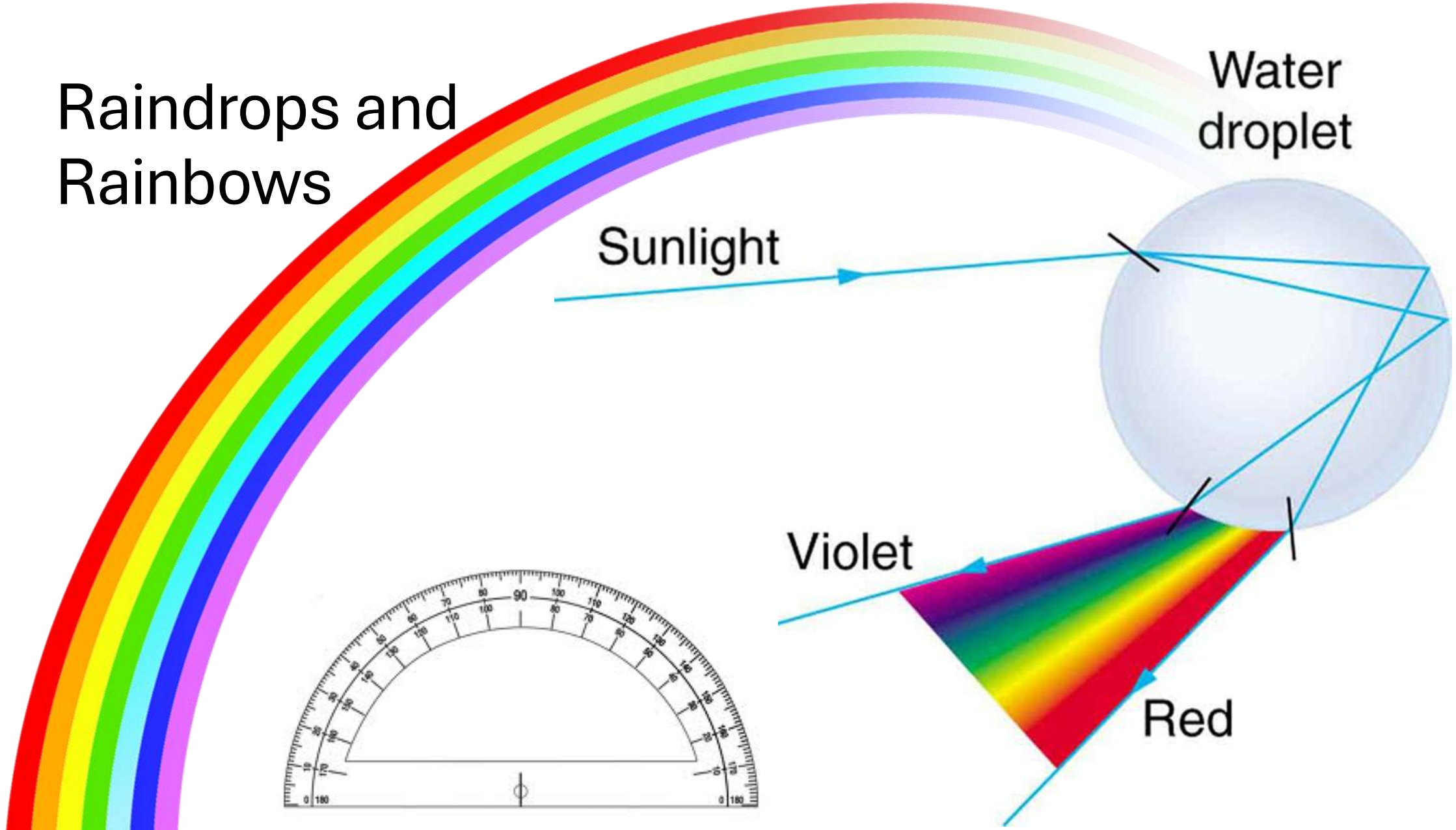


WHAT IS THE COLOR OF SUNLIGHT?

The color of sunlight is essentially white. This is because sunlight consists of an even distribution of all colors in the visible light spectrum, which, when combined, form white light.



Raindrops and Rainbows







God's Promises are Sure! One day we will see them ALL?

"I have set my rainbow in the clouds, and it will be the sign of the covenant between me and the earth." Gen 9:13

"…and there was a rainbow around the throne, like an emerald in appearance." Rev 4:3

"As the appearance of the rainbow in the clouds on a rainy day, so was the appearance of radiance all around (the throne and glory of Yahweh)." Ez 1:28

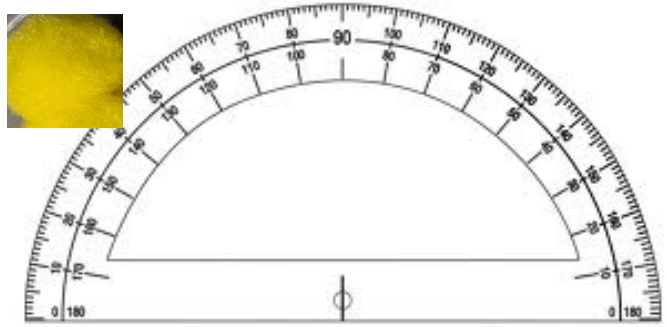
The Photoelectric Effect Sunlight – Color and Angle

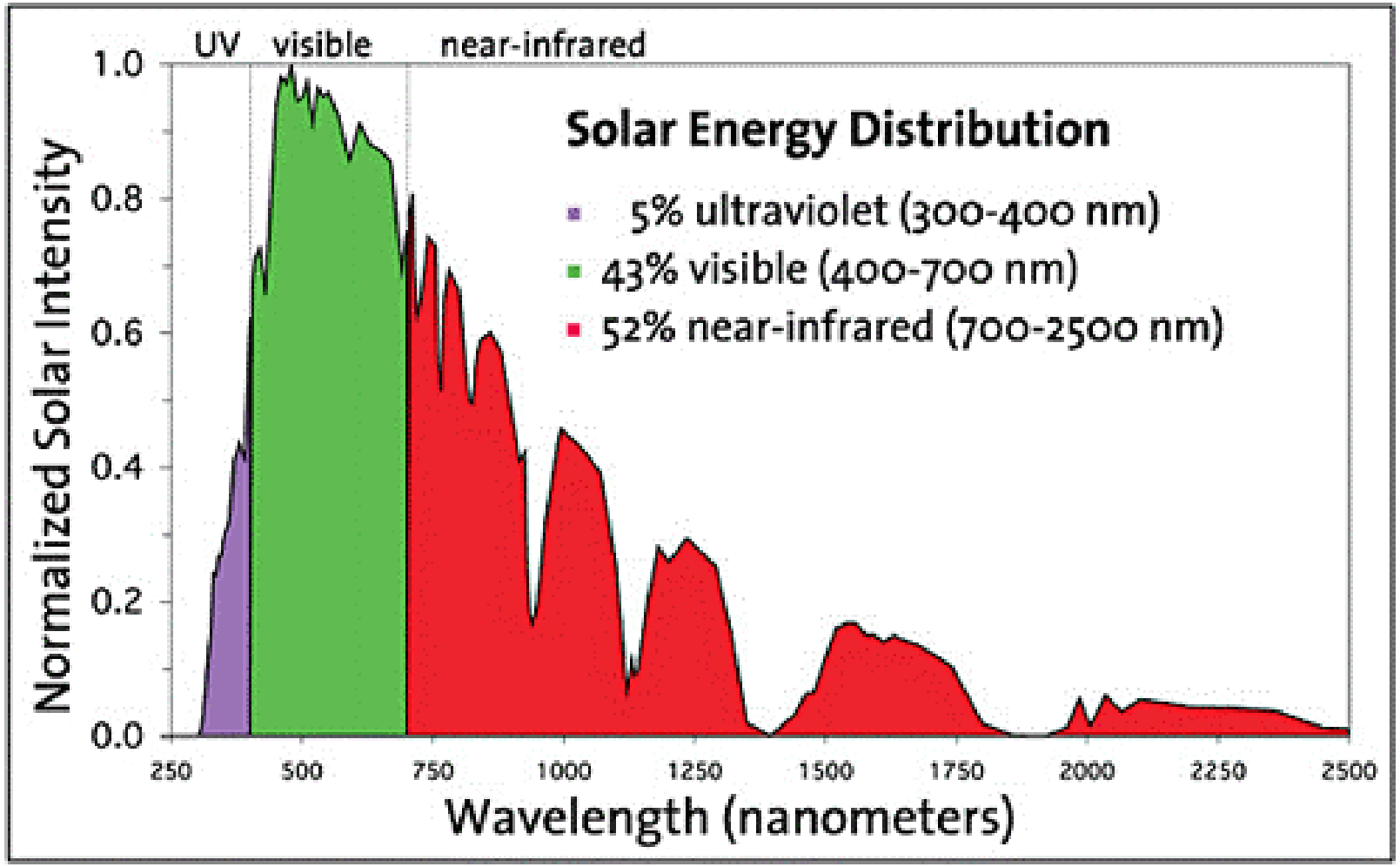
Water Evaporates Best

at about 45°

at peak wavelength

~500 nm (green)





Measuring & Science

Like a recipe requires just the right amount of ingredients to taste good, Science often requires us to measure things:

- Mass (weight)
- Distances or (l x h x w)
- Time
- Volume
- Quantity (number of things)



Volume is often important in chemistry

Kitchen measures like:
Cup, Tablespoon, or Teaspoon are volume measures. In chemistry we often use:

- mL (milliliters)
- cm^3 (cubic centimeters or cc)

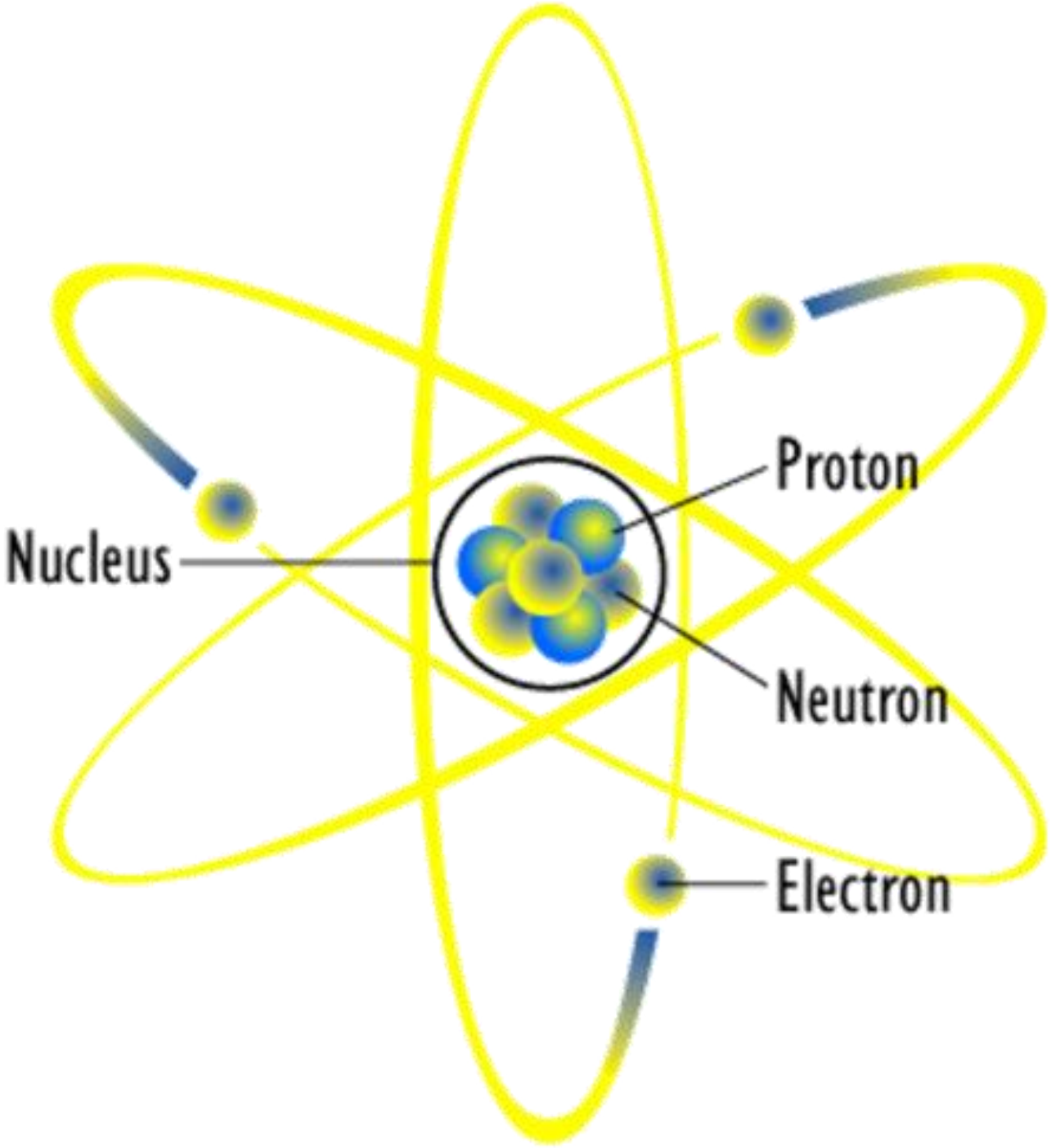


STANDARDS

1 cm^3 = 1 mL also = 1 gram

If we are measuring water, **1 g of water weight = 1 cm^3 = 1 mL H_2O**

In a Chemistry Class you often measure MOLES or numbers of atoms in a mixture to mix things correctly – and not blow things up!?!



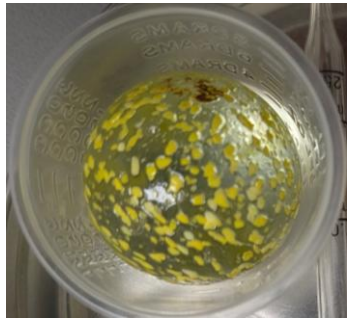
One Mole of Water



A mole contains 6.202 x 10^{23} atoms x its # of elements

620,200,000,000,000,000,000,000 atoms of each element

If you have that many atoms together, you can usually see the mole or matter/element/compound. Just like you could see 18 mL of water you measured, you can also see a mole of glass (silica).



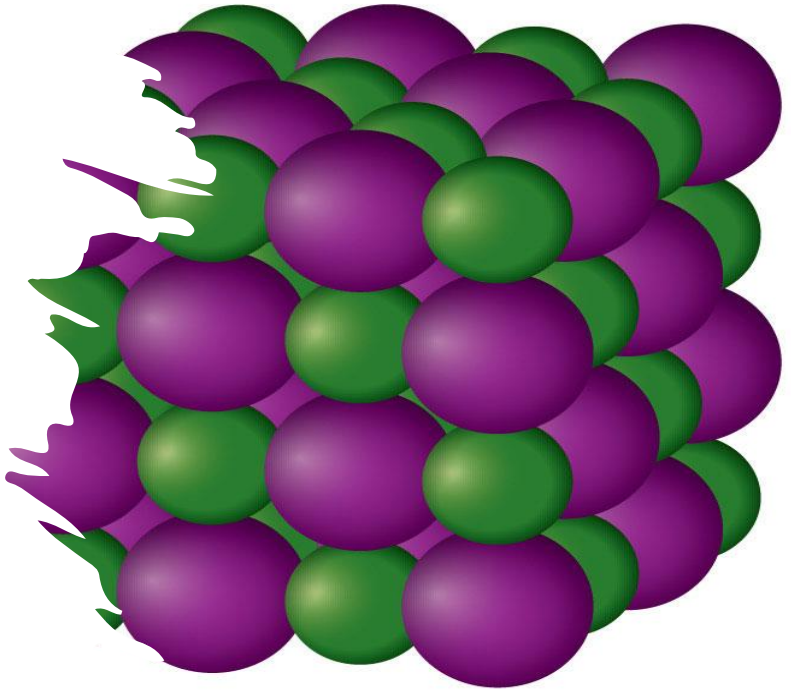
On the far right is a mole size = to water, to sulfur, and to a mole (i.e., a mole of pure carbon).



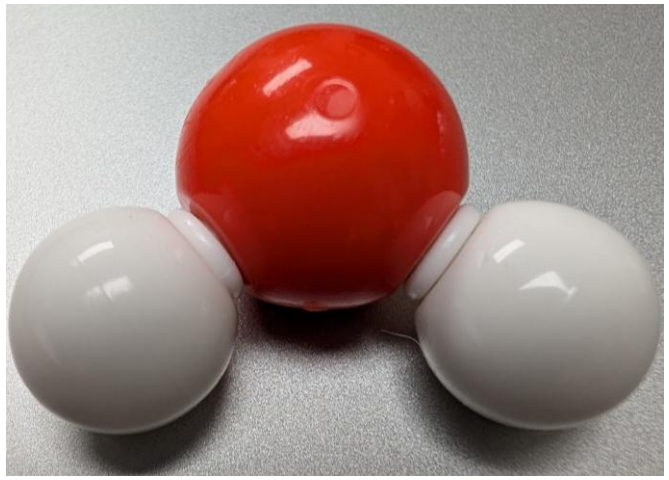
Mole sizes can be vastly different
Moles measure molecules

- A mole of gas is at room temp (or standard pressure/temperature) is around 22-24 liters (12 two-liter soda bottles)
- A mole of sugar/glucose is 117 mL or about ½ cup – almost 10 times more volume than a water molecule.

But all moles, little and big alike, have 620,200,000,000,000,000,000 or 620 sextrillion atoms of each element (times the number of each) in the molecule.

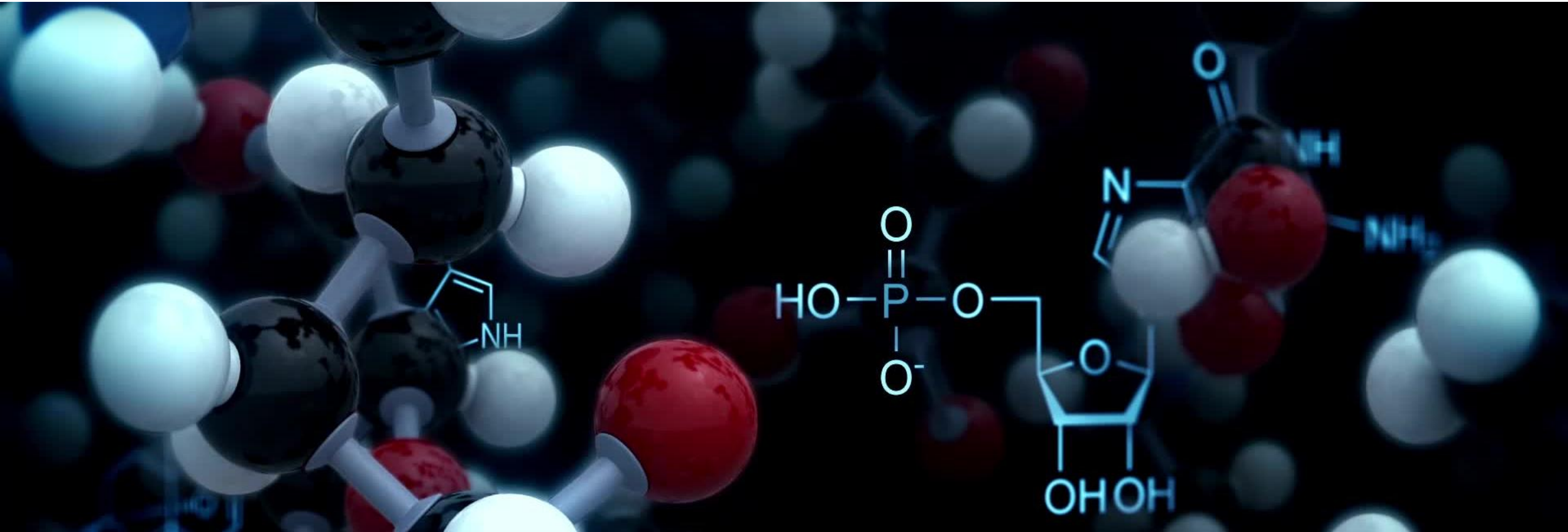


Water has 3 atoms per molecule.
1 mole of oxygen…
And 2 moles of hydrogen…
for a grand total of 3 x 6.202×10^{23} or 18.606×10^{23}



Wooaa… That’s a lot of atom counting!!!

The number of atoms in each molecule is important so the attraction of each (charge of each atom) can **be balanced**.



Moles are to Molecules as…

- Cups to flour & butter
- Tablespoons to sugar
- Teaspoons to vanilla, ginger, & cloves

Just a way to get it all

RIGHT!!!





4 g of sugar =

1 teaspoon



Thank Goodness, we can measure volume!

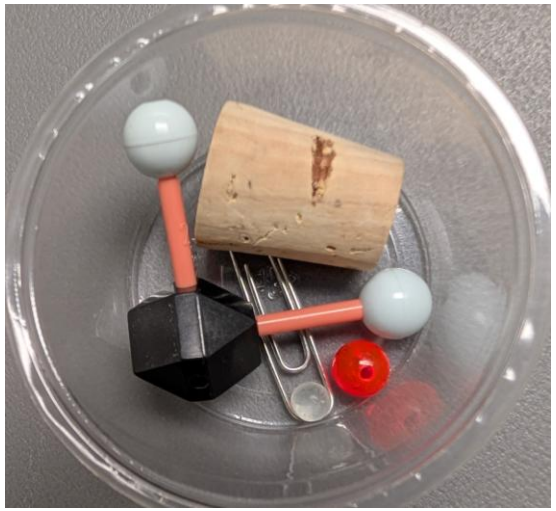
- Thankfully, **we can measure** things we need to add to a recipe (and not count salt or sugar grains).
- Scientists have measured (and weighed) the atoms so we don't have **to figure out some way to count atoms we can't even see!!!**

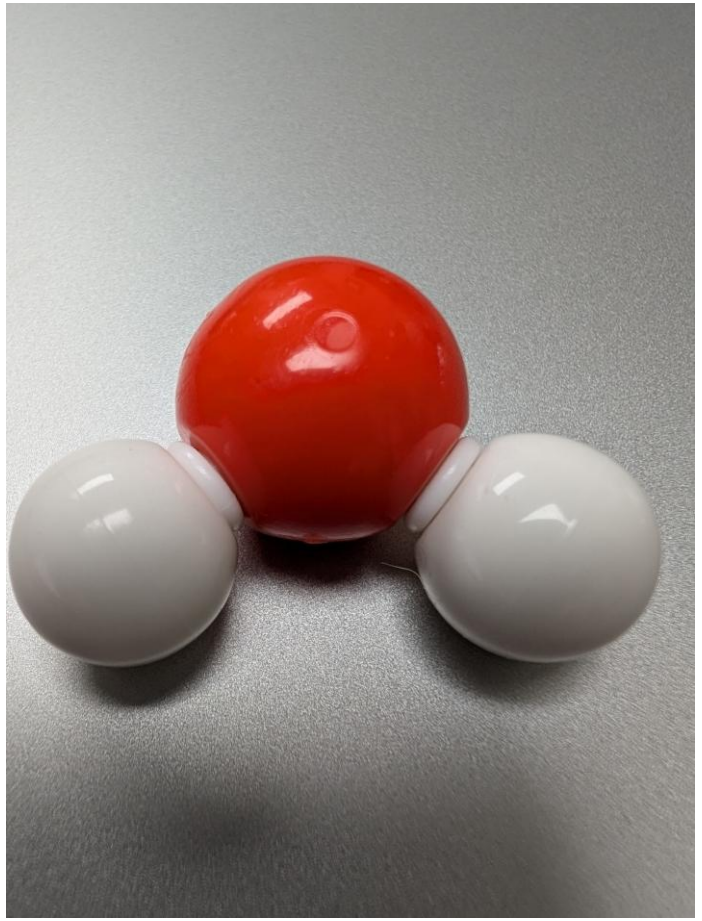


Lab Enrichment











The Significance of Water on Earth

- Capable of 3 states of matter at earth's temperatures
- Evaporates and Condenses
- Expands when freezing
- Response to sunlight
- Cleanses our planet
- High Heat capacity
- Universal Solvent
- High Surface Tension
- Promotes capillary action
- Responds to the Moon's pull
- Responds to the Sun's light



God made the earth to be inhabited…Is 45:18

- God gave us matter to breathe, drink, live, work, serve, and play
- He carefully crafted the amazing properties of water (just right…)
- He created the sun to heat Earth's land & water just right (photoelectric)
- To give us the water cycle to supply all our freshwater needs
- He gave us the vast oceans to keep Earth warm
- Without water's 3 phases at Earth's temps, the water cycle wouldn't work



Lab Worksheets

WATER LAB WORKSHEET #3

WATER
Chemistry

In the Bible, water often symbolizes cleansing and indeed it's our body's best friend both inside and out. Raindrops form on dirt particles to clean our air. "Wash yourselves; make yourselves clean; remove the evil of your deeds." Isaiah 1:16

WATER IS:
Odorless, tasteless, and transparent/colorless. In chemistry, it is a universal solvent, dissolving molecular substances. It's the standard (1) used in measuring volume, weight, densi specific gravity. More than 70% of earth, of our muscles and organs, and of our diet i water for hydration and cleansing. Many cleansing systems are sustained by water's

VOCABULARY:

Ocean Circulation	water cycle	filtration system (2)	Fresh Water S

1. Our kidneys serve as a _____ for fluids and require lo

2. The _____ circulates water from Earth's surface to the air and back rivers/streams, lakes, and the ocean.

3. _____ transfer water or melted ice from mountains to streams, lakes, and oceans.

4. _____ moves water in the ocean supplying oxygen, nutrients cleansing power to prevent stagnation.

5. To survive in the wilderness where water may contain harmful impurities, carrying _____ is advisable. Clean water is essential to staying alive.

Due to a water molecule's polarity, many impurities are attracted to it and can b of our bodies or other systems.

FRESH VS OCEAN WATER:

Saltwater has a lower temperature of freezing than freshwater.

Name 2 examples of freshwater organisms and include something unique about its c

a. b.

Name 2 examples of saltwater organisms and include something unique about its de

a. b.

WATER LAB WORKSHEET #5

WATER
ICE

Water ice covers about 10% of Earth's surface. Its presence promotes a temperate climate. Too little ice means more solar radiation is absorbed and the Earth heats up too much. Too much ice and the Earth is too cold. God "...created Earth to be inhabited." Is 45:18

Because water expands in its frozen state, it is lighter and floats. Without this unusual property, Earth would become frozen solid.

VOCABULARY:

floats	hexagonal	salt/ocean water	90%	9%

1. _____ Water ice or snow reflect _____ of sunlight and help climate cooling.
2. _____ When water freezes, it expands by _____.
3. _____ The structural/atomic shape of ice molecules.
4. _____ Ice _____ and forms a protective insulating layer for marine life.
5. _____ Melting ice/fresh water is lighter than _____ and provides drinking water for various species, including humans.
6. _____ One reason water can dissolve other molecules.

SUBLIMINATION CAUSES:

Photoelectric/molecular effect	Kinetic Energy	Vapor Pressure Drop

Give 2 examples of water ice sublimating at cold temperatures due to one of the above?
a. b.
b.

1. _____ Transferring wind or circulation energy to an ice molecule increasing its vibrational energy (thermal energy rise).
2. _____ "Zapping" ice with light/photon energy from electron transitions energizing the phase change.
3. _____ happens with an imbalance of low and high moisture saturation on an icy surface resulting in a vacuum or pump-like action. Dry winter air or a freezer circulation system will "pump" water

WATER LAB ENRICHMENT Worksheet 3

WATER
Phase Change

God's amazing grace showers us with life-giving rain, freshwater streams, and a world where water exists naturally in 3 states of matter. All 3 phases are essential for life to exist on Earth.

VOCABULARY: Change Actions/Conditions

Melting	Freezing	Condensing	Evaporating	Boiling	Sublimation

1. _____ a solid turns into a gas/vapor, skipping the liquid phase.
2. _____ a liquid hardens into a solid (ice).
3. _____ a gas/vapor transforms to a liquid (rain/water).
4. _____ a liquid slowly converts a gas/vapor (steam/clou
5. _____ a solid transforms into a liquid (water).
6. _____ an action or temperature where liquid quickly tu

NGE:

100° C	32° F	212° F

ıs) – water freezes.

elow _____ (Celsius) – water is a liquid.

elow _____ (Fahrenheit) – water is a liquid.

nheit) – water is a solid.

ıs) and _____ (Fahrenheit) – water boils and va

WATER LAB WORKSHEET #5

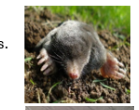
WATER
Mole Chem

Isaiah 40:12 asks, "Who measured heaven with a span," and Revelation 21:16 gives the measures of the New Jerusalem, a perfect square, at 12,000 stadia – length, width, and height. Chemistry uses moles and molar mass to measure, compare, balance, and equilibrate.

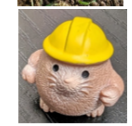
CHEMISTRY:
Chemistry often deals with mixtures and precise amounts, much like baking in a kitchen. Too much or too little of any ingredient can ruin the "kitchen chemistry" you're hoping will be edible. Chemistry reactions deal with precise amounts of specific elements and substances to achieve: equilibrium, phase change, chemical reactions, atomic bonding, and so on... To measure and achieve these goals, "**MOLES**" are used to gage and predict the outcome.

A Mole: A mole is the SI unit used to measure substances. *Avogadro's number, 6.022... x 10^{23} atoms, is the total number of atoms in ONE mole (mol) of a substance. Its numerical count is derived from the number of atoms in 12 grams of carbon-12.*

Molar Mass: The mass of one mole of a substance expressed in grams/moles.



FACTS ABOUT 1 mol of H_2O: Water has a molar mass of ~18 g/mol. It's volume is 18 mL (milliliters). As an example of what this size looks like, it's sphere with a 3.25 cm or 1 ¼", about the size of a small rubber ball.



A mole of sulfur (yellow) is a bit smaller, about the size of a pom pom. And a mole of silica/quartz/sand is a little larger, about the size of a 1 1/2" glass sphere or large shooter marble size.

VOCABULARY:

Mole (mol)	Atomic Mass	Molar Mass	Hydrogen	Oxygen	Polarity	Molecule

1. _____ Water contains 2 of these atoms per every 1 oxygen atom.
2. _____ The sum of protons + neutrons in an element (or an average).
3. _____ A unit amount of 6.022 x 10^{23} atoms of an element.
4. _____ The mass in grams of 1 mol of a given substance.
5. _____ The "heavier" element bonding with 2H's in a molecule of water.
6. _____ One reason water can dissolve other molecules.

Lesson 1 – 4 Levels (Grade/Proficiency)

VOL 1 O2K SCENIC SCIENCE LEVEL 1

SCENIC SCIENCE **LESSON 1 CHEMISTRY**

MATTER: WATER

Ready Answer

Lesson #: Vol 1 Lesson 1a - **Level 1**
MATTER: Water
Devotion 1: Genesis 1:1-3 In the Beginning, God…



Lights, Cameras…

Scene 1: Our story begins without the heavens and the earth – dark and empty.

Scene 2: Then, God created our universe – the beginning of time and space.

INSTRUCTIONS:
1. Complete Lab Explorations Level 1
2. Challenge – Review and/or complete Level 3
3. Apply what you learn in the lab

FOUNDATIONS

GENESIS 1:1 *[1]In the beginning, God created the heavens and the earth.*



Earthrise was taken by NASA.

"In the beginning, God…" Genesis 1:1 tells us 1) there was a time when our world didn't exist, and then, 2) God created the heavens and the earth. From the Bible, we can know how and when things happened. While science can help us **know**. God's Word is a **higher way of knowing**.

So, what does the Bible tells us about the CREATION event?

TAKE

a. **In the Beginning tells us WHEN!**
b. **God Created tells us WHO!**

SCENE #1 – DARKNESS with no earth or heavens (no sky, planets, stars, or galaxies)
SCENE #2 – CREATION through an act of GOD.

Only God could tell us about the Beginning because no one else was there (God the Father, Son, and Spirit were acting together to create). No earth-based life existed; therefore, the only eyewitnesses were God. However, all of creation is evidence for the beginning. Even scientists have concluded our universe had a beginning.

MATTER – What was created?

Genesis 1:3 tells us, the Spirit of God moved on face of the waters. 2 Peter 3:5 says the earth was formed out of water. The earth, the heavens (sky and space), and water – all are matter.



1. **Matter** is anything that has mass (aka inertia) and occupies space.
2. Matter is made up of atoms. **An atom** is smallest unit of matter.
3. An **element** is a pure substance made up of only one type of atom.

O2K CODES IN SCIENCE LEVEL 2

LESSON 1 CHEMISTRY

MATTER: WATER

a - **Level 2**

-3 In the Beginning, God…



INSTRUCTIONS:
1. Complete Lab Explorations Level 1
2. Challenge – Review and/or complete Level 3
3. Apply what you learn in the lab

FOUNDATIONS

GENESIS 1:1-2 *[1]In the beginning, God created the heavens and the earth. [2]And the earth was without form, and void; darkness was upon the face of the deep. And the Spirit of God moved upon the face of the waters.*

Detectives investigate. They search for evidence and they analyze what they find. This process is called science or forensic science. Our challenge is to use a similar method to explore creation.

…inning! But what it doesn't tell us is, "Who *done* it?" We can …tion, but we can't observe the "event" of creation or WHO … in the past.

…eavens and the earth in verse 1. In verse 2-3, the Bible tells us …e way a detective would. If you were a detective and you had …/HO did it and HOW – your investigation would be finished.

…se questions about creation without using the eyewitness …/theorize what happened: HOW was it done? WHAT CAUSED …nd? The EVIDENCE for a creation event is the universe itself



O2K CHEMISTRY SS+ LEVEL 3

…AL SCIENCE **LESSON 1 CHEM**

MATTER: WATER

Vol 1a: Lesson 1 - **Level 3**
Chemistry: Elements & Molecules/Water
Devotion 1: Genesis 1:1-3 In the Beginning, God…



…val Challenge: 1) Why is water …ial to survival? 2) How do its …ties promote life? And 3) How can I …dvantage of these properties?

INSTRUCTIONS
1. Complete Lab Explorations Levels 1-2
2. Challenge – Review and/or complete Level 4
3. Apply what you learn in the lab

…TIONS

…1:1-2 *[1]In the beginning, God created the heavens and the earth. [2]And the earth was without form, … darkness was upon the face of the deep. And the Spirit of God moved upon the face of the waters.*
…:5b *…earth was formed out of water and by water.*

…TED: Verse 1 is considered an introduction to the 6-days of Creation – the topic sentence …mmarizes the "rest of the story." The verb, created, indicates action/energy was used. The …word "bara" meaning a NEW CREATION suggests it never existed before or it was created …othing."
…ook up the Latin expression *ex nihilo* & define: _____ _____

…LESS: Based on verses 1 & 2, would you assume that the earth was destroyed and …d, or that verse 2 is simply telling how God formed the earth?

…D UPON: Truth and insights were wrapped in these 2 verses. Science reveals 2 primary …ls are needed to build any substance. These are form and energy. Without them, there is …otiness – a void. Is it coincidence that both are included in these verses? Y / N

…ETICS

Survival Tips

…rom your …ent.
…e SEEKING …ding resources …dge.
…ment to find out …ks.

2 COR 10:5 We demolish arguments and every pretense that sets itself up against the knowledge of God, and we take captive every thought to make it obedient to Christ.

Science is the quest for knowledge. Seeking answers is a God-given pursuit. "Seek and you will find. Knock and the door will be opened to you." Mathew 7:7 "Beloved, do not believe every spirit, but test the spirits to see whether they are from God, for many false prophets have gone out into the world." John 4:1

Finding answers through seeking and testing isn't unique to the "field" of science, rather it's the route to discovery for all. Therefore, we shouldn't dismiss things labeled "science" as something scientists do.

O2K - Chemistry Level 4

LESSON 1 CHEM

…TER: WATER

…lecules/Water
In the Beginning, God…



INSTRUCTIONS
1. Review CHEM Lessons Levels 1-3 (built on previous levels MATTER: Water)
2. Challenge – Use Apologetics & Applications in Class
3. Be Prepared to Give an Answer/Evidence for your Hope

…ited the heavens and the earth. [2]And the earth was without form, …he deep. And the Spirit of God moved upon the face of the waters. …ter and by water.

…n verse 1, "*bara*" indicates a NEW CREATION, *ex nihilo*. …lways associated with God's actions. In the Bible, if man …d (*asah* and *yatzar*). In addition, Genesis1:26 uses the word …xt, "*Let us make man in our image.*" Immediately following, …n… Does using *bara* seem purposeful in Genesis 1:1-2?

…is translated as deep, abyss, or chaotic mass of elemental … abode previously, or came about "In the beginning…," we *…e showed me a pure river of water of life, clear as crystal, …d of the Lamb. In the middle of its street, and on either side …ore twelve fruits, each tree yielding its fruit every month."*

…ving from the throne of God (described in Rev. 22:1-2). …heaven, a river flows that is known as the "water of life." …' flowing out from the Temple (Ezekiel 47). It's also revealed …h was formed (2 Peter 3:5), and out of water the heavens

…5. New life in the womb is surrounded by an envelope of …w life is imminent. Read John 3:5, 8 and Titus 3:5. What …y water?

…ord *ruach* for Spirit is also translated life giving power, wind … translated hover, flutter, or shake. It's clear that God's … What two entities are all creation, all-natural physical

Lab Supplies + Lab Posters + Worksheets

